# MARKET CENTRES
# AND REGIONAL DEVELOPMENT

# Market Centres and Regional Development

(A Case Study of Delhi-Jaipur-Agra Triangle)

ROCKET IBRAHIM

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New Delhi

Rocket Ibrahim

# Foreword

Dr. Rocket Ibrahim's work is a welcome addition to the slender collection of contributions by geographers to an understanding of the regulation of commodity flows by market centres in the context of regional development.

A survey of research in transportation studies reveals a growing body of literature dealing with a variety to themes. A search therein for cohesive theoretical constructs or methodological consistencies would not, however, be very rewarding. This body of literature is highly fragmented; and unifying as well as synthesising conceptualizations therein are weakly developed. The present work is particularly significant in this context. It is fairly strong in terms of its empirical base. its analytical framework and its methodological rigour.

An analysis of the pattern of commodity flows is of considerable significance in assessing the levels of regional development in an economy. This follows from the role played by commodity flows in changing the geographical position of goods in two ways—firstly. by moving the intermediate inputs to locations where these can be processed more economically; and secondly, by distributing the goods to various demand centres for final consumption. These processes are operationalized through the system of transport networks. Commodity flows are thus a manifestation of the pattern of resource distribution and the level of its utilization. It follows from this that the level of inter regional trade increases with growing regional specialization in the production processes.

The vertical dimension of the inter-sectoral transactions that are usually articulated through input-output matrices finds its horizontal er spatial manifectation as freight exahange between different categories of settlements in different regions over a range of distances in the space economy. Viewed thus, commodity flows constitute the basic links through which the diverse elements of the space economy get integrated into a functional, dynamic and hierarchical system. In view of the territorial division of labour, differential accessibility and regional differentiation, on the one hand, and of the economies of scale, agglomeration and urbanization, on the other, economic activities display a tendency towards clustering and concentration in space. The very fact that a large volume of traffic terminates over short distance testifies to the positive impact of the "friction of distance" on the economies of scale.

Inter and intra-regional movement of commodities reflects the interlinkages among the sectoral as well as the territorial components of the space economy, which assume the form of direct input-output type of relationships between the production system of a given region and the final demand sector located within others. The production of goods and services involves the bringing together of the various intermediate inputs to a territorial production system from different sectors and over a range of distances within the limits imposed by transportation costs and political or cultural barriers. These intermediate inputs are then transformed into products, that are in demand in the same or other regions of the economy. Each region thus specializes in the type of production in which it enjoys a comparative advantage and exchanges its specialities with other regions of the system. The exchange of goods producing and concuming centres results in a regular pattern between the of commodity flows, where in the flows of commodities linked with one another. With scuh a model of the space economy in view, it should be possible to use commodity flows as an analytical tool for the study of the strength and weakness of the regional structure of a national economy.

The present work has probed into the efficiency of the

transport network and the role of market centres as regulators of commodity flows from the rural hinterland to the rest of the region and the country. The researcher has established that market centres with high nodal accessibility command larger arrivals of the agricultral marketed surplus. What is of particular significance in the present study from the point of regional development is the recognition of a hierarchical order of market centres on the basis of the quantity of produce brought to the market for disbursement as well as of transport nodality. It is interesting to note that the hierarchical system based on the two factors basadly coincide with each other in economic space.

The study is based on Delhi-Jaipur-Agra triangle or the traditional region of Mewat, which poses a serious challenge to regional development planners. It constitutes one of the most backward parts of India situated in the close vicinity of the urban development of the national capital. This model of the richest and poorest areas of a country rubbing shoulders with one another is a characteristic of all under-development economies, wherein metropoles have shown an incapacity to become centres for the diffusion of growth impulses and therefore continue to be enclaves of dysfunctional development.

The author should also be complimented for a fairly elegant use of the stepwise multiple regressicn model for probing into the nature of relationship between marketed surplus, as the dependent variable and the indices of transport network nodality of market centres as explanatory variables. It has thus become possible to measure the contribution of each independent variable in explaining the variance in the amount of the receipt of agricultural products in the markets. Skilful and innovative use has been made of the relative residuals from the simple as well as step-wise multiple regression by plotting them on maps and analysing the quantum and nature of the unexplained variance.

This is the first work of Dr. Ibrahim. It is a work of substantial merit which shows great promise. It augurs well

for studies on the Mewat region, on the one hand, and for transport as well as marketing geography, on the other.

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Regional Development,
Jawaharlal Nehru University,
New Delhi.

Moonis Raza

July 25, 1984

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# 1

# Introduction

## 1.1 Introduction :

There is strong positive relationship between the development of a region and its level of accessibility to resources and the markets. At present, the transport system has developed to overcome the geographical distances. Regional scientists are of the opinion that atleast in short duration the initial growth of a region, depends upon the ability of a region to produce goods and services which are for itself. While offering these goods and services in market it must also be in a position to compete with other regions. This ultimately depends on the existing transportation facilities which link consumption and production centres within and outside the region, which ultimately reflects the pattern of growth. In other words, an efficient transport connection develops regional resources on the basis of inter-regional comparative advantage. The extensive transport network system helps in developing larger internal markets in the region and brings together several markets located in different regions. Thus transportation and market network are the reflection of the internal economic structure of the region.

This study is concerned with an analysis of the transport network efficiency and market centres (mandis) in a region

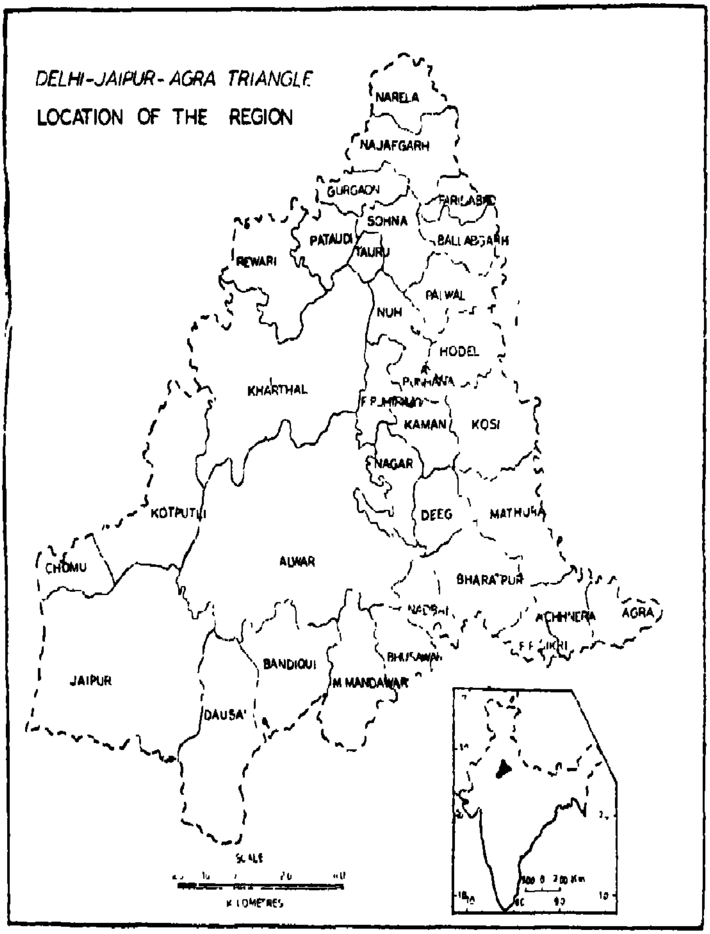

DELHI-JAIPUR-AGRA TRIANGLE
LOCATION OF THE REGION
NARELA
NAJAFGARH
GURGAON
SOHNA
PATAUDI
TAURU
REWARI
BALLABGARH
PALWAL
NUH
HODEL
KHARTHAL
KAMAN
KOSI
NAGAR
KOTPUTLI
DEEG
MATHURA
CHOMU
ALWAR
BHARATPUR
ACHHNERA
AGRA
BANDIQUI
JAIPUR
M MANDAWAR
DAUSA
KILOMETRES

Fig. : 1.1

delimited by the National Highways joining Delhi, Jaipur and Agra and forming a triangle in the north-western part of India (Map No. 1.1). Efficient transport network system of the mandi centres has a direct impact on the quantity and extent of mandi arrivals and hierarchy of mandi centres, is one of the basic themes of this study. The indices of transport network development of mandi centres mandi hinterlands have been identified, discussed and correlated.

Inquiry has been made into the fact whether it is the efficient transport network system of the mandi hinterlands or the efficient linkage system of mandi centres within the region and out side the region which influence the marketed surplus. For the farmer, the most important task is how to transport his produce to the market. He may have many markets around but has to weigh the transport cost and time against the returns from the sale-proceeds. The task is not complete even after the arrival of produce to the mandi. An important thing to know is how efficiently these mandi centres perform their function as outlets to the region's agricultural produce. Hence the village accessibility has to be viewed in context of the complete transport network system. The quantity of the produce brought to the market for disbursement and the nodality of such market vis-a-vis transport connectivity and accessibility help in identifying the hierarchical orders in market centres.

## 1.2 Region and its Selection :

The region covers an area of 12,316 km.[2] between Delhi, Jaipur and Agra National Highways, extending over Union territory of Delhi, districts of Gurgaon and Faridabad in Haryana, Alwar, parts of Jaipur, Bharatpur, Sawai-Madhopur in Rajasthan and Mathura and Agra in Uttar Pradesh (Map No. 1.1). Its latitudinal and longitudinal extent is from 26°.43′ North to 28°.53′ North and 75°.30′ East to 78.°30′ East. The study area has derived its name Delhi-Jaipur-Agra Triangle because it covers the area which lies between Delhi-Agra national highway No. 2, Delhi-Jaipur national highway No. 8,

and Jaipur-Agra national highway No. 11, which is apparently a triangular region. All the notified mandi-areas which are in between or are crossed by these three national highways, constitute the region. In all, there are 34 regulated mandis in the region.

The Delhi-Jaipur-Agra Triangle area has been selected because it comprises a complete system of road network. This region is traversed by a net of national highways, state highways, district-roads and village roads. Hence it is called a complete system of road network. This makes the transport network analysis more meaningful while understanding the regional variations in the transport network development in the region. Secondly, the natural diversities and a varied character of the terrain provides abundant scope to study the regional structure of regulated mandis of different classes. Thus, the study area is important because it has large regional variations in the agricultural marketing pattern as well as its character of transport network. It provides an opportunity to conduct a comparative study in the region to understand as to how the transportation and agricultural marketing system along the alluvial plain of Yamuna differ from that of the region along the Aravalli and the semi-desert area in the south-west.

There are well marked physiographic influences on the distribution of mandi settlements and transport network of the region. The shortest transport routes over the Aravalli region are deflected from the shortest path because of the physiographic unevenness. These strong influences of the physical lay-out of the terrain not only guide the location of the transport and communication routes but also reflect the nature of hinterlands of different mandis, their regional specialization and functional character. For instance, the eastern part of the region, particularly along the Yamuna river and south-eastern part which has good drainage system, irrigation facilities and fertile alluvial land, can grow large quantity of wheat and sugarcane, which may not be grown so profitably in the south-western part of the region.

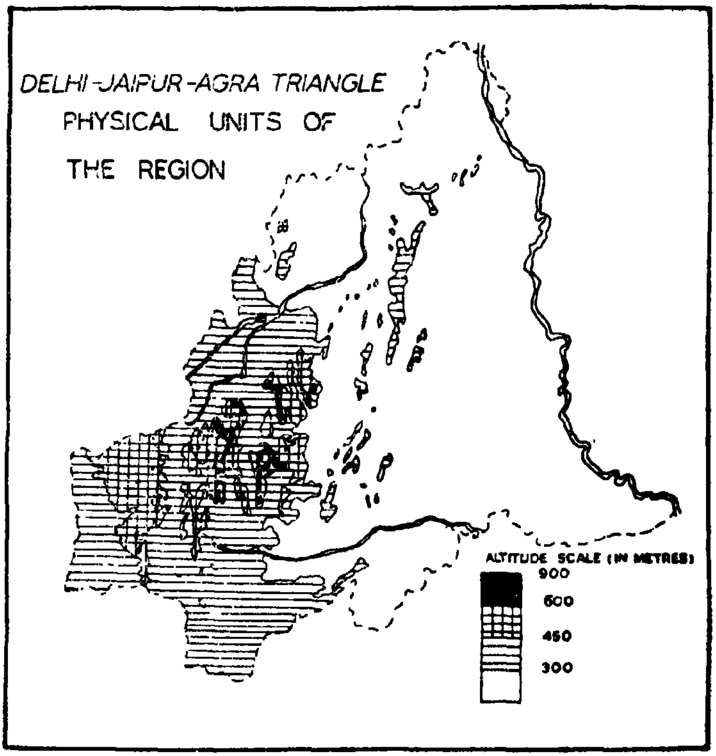

DELHI-JAIPUR-AGRA TRIANGLE
PHYSICAL UNITS OF
THE REGION
ALTITUDE SCALE (IN METRES)
900
600
450
300

Fig. : 1.2

The Aravalli hills which extend from north to south (Fig. No. 1.2) over a considerable area in the western part of the region, become a physical barrier to the agricultural producers in transporting their produce to either side. The farmers of west cannot take their goods to east and vice-versa, inspite of the price differences. Uneven, rugged and sandy areas in the south-west are not favourable for much agricultural market surplus. Kotputli, Bairath, Amber, Jaipur, Bassi, Jamwa Ramgarh, Dausa, Thanagazi, Alwar, Bansur and Mandawar tehsils, located in south-west, have comparatively high altitude, ranging from 300 to 600 metres. Most of the area of these tehsils has rugged surface. This is also the area where we find maximum deflection of the transport routes. The tortuosity ratio, which has been discussed in detail at later stage, is highest for these areas. Most of the area along Yamuna river is a level, fertile and alluvial plain with low altitudes. The hilly region of southwest is intersected by Sabi and Banganga rivers and their tributaries and other drainage lines. Yamuna river forms eastern boundary of the region.

Physiography, drainage and climatic characteristics exert their influence simultaneously. The road transport routes strongly follow the longitudinal direction of the Aravalli range. There are two important routes on either side of the range. One is Delhi-Gurgaon-Alwar-Jaipur route and the other is Delhi-Gurgaon-Kotputli-Jaipur route. Both these routes get adversely affected during rains. Many a seasonal rivers flowing down the hills have been harnessed for irrigation purposes by building dams. But during the rainy season, an unexpected increased volume of water may overflow the dams and damage the adjoining road-network and crops. Because of this type of relationship, the description of drainage and climate also becomes inevitable. Most of the rivers of the area arise from Aravalli hills. Several of the rivers and their tributary channels which carry the drainage of the hills are useful because of their floods which enables that area for sowing. The silt of some of these streams is highly fertile and crops are grown in the river beds after the rainy season. On the whole, drainage lines are few and most of them are dried

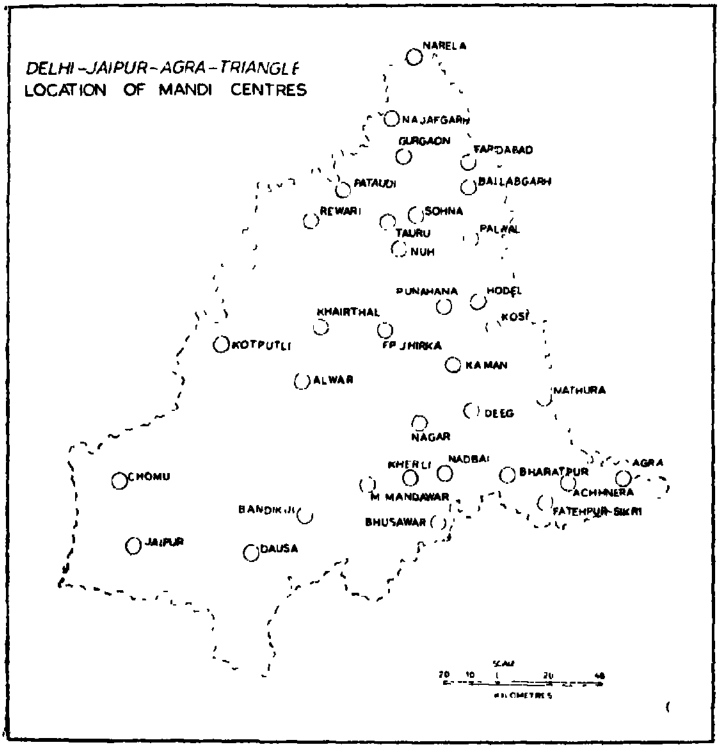

DELHI-JAIPUR-AGRA-TRIANGLE
LOCATION OF MANDI CENTRES
NARELA
NAJAFGARH
GURGAON
FARIDABAD
PATAUDI
BALLABGARH
REWARI
SOHNA
TAURU
PALWAL
NUH
PUNAHANA
HODEL
KHAIRTHAL
KOSI
KOTPUTLI
FP JHIRKA
KAMAN
ALWAR
MATHURA
DEEG
NAGAR
KHERLI
NADBAI
BHARATPUR
AGRA
CHOMU
M MANDAWAR
ACHHNERA
BANDIKUI
FATEHPUR-SIKRI
BHUSAWAR
JAIPUR
DAUSA

**Fig. : 1.3**

up within few months. The region has semi-arid type of climate. The whole area can not enjoy full benefits of the monsoon season. The unreliable rainfall takes place during the month of July, August and September and dislocates the transport system.

There are large variations in the development of this region. Delhi state in the north and district of Agra in south-east have very high level of development. Both these are located at the national highway crossings. Mathura in southeast, Jaipur in southwest have high level of development. The heart of the region (which covers almost half of the total area) has low level of development. Most of the area of this continuous zone is hilly and uneven. In the north of this zone and south of Delhi is the area of medium level of development.

### 1.3 Spatial Distribution of Mandi Centres :

The location of mandi centres has been effected by the large physiographic and economic diversities in the region. Out of total 34 mandis (Gurgaon, Faridabad, Ballabgarh, Pataudi, Sohna, Rewari, Tauru, Nuh, Palwal, Hodel, Punahana, F.P. Jhirka, Mathura, Kosi, Agra, Mahwa Mandawar, Bharatpur, Deeg, Kaman, Nadbai, Bandikui, Chomu, Dausa, Jaipur, Kotputli, Alwar, Khairthal, Kherli, Najafgarh, Narela, Fatehpur Sikri, Achhnera, Bhusawar and Nagar) 14 are located on the national highways. Of these 5 are village mandis and 29 are located in urban settlements. Along the Aravalli range and in the south western part of the region, which is characterised by hilly and desert topography the mandis are sparsely distributed. The region includes 2 mandis of Delhi, 15 mandis of Rajasthan (6 in district Bharatpur 5 in Jaipur district, 3 in Alwar district and one in Sawai Madhopur district), 5 mandis of Uttar Pradesh (2 mandis of Mathura and 3 mandis of Agra district) and 12 mandis of Haryana state in between Delhi state and Uttar Pradesh-Rajasthan states (Fig. 1.3).

The distribution pattern (Map No. 1.4) observed by the

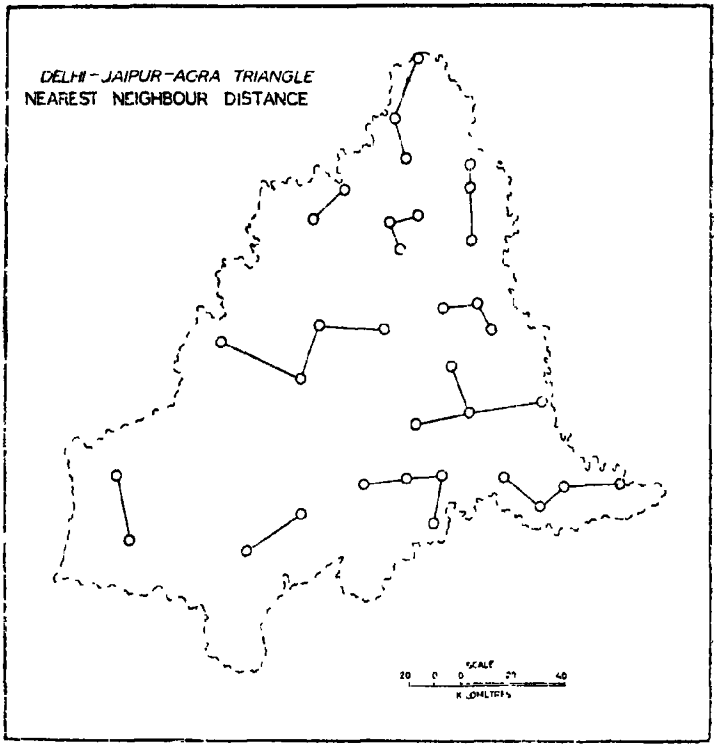

DELHI - JAIPUR - AGRA TRIANGLE
NEAREST NEIGHBOUR DISTANCE
20
0
40

**Fig. : 1.4**

use of nearest neighbour technique* gives a more regular than random picture of mandi centres located within the triangle, with RN value placed at 1.55 (Fig. No. 1.4).

## 1.4 Data Base :

Topographic sheets, district gazetteers, techno-economic survey, census tables and reports of Haryana, Uttar Pradesh, Rajasthan and Delhi are the basic sources on which region's socio-economic and physiographic description is based. Measures of transport network structure were derived from the district road maps, which were collected from the public works department's district headquarters. The published bus time-tables and registered private bus routes at regional transport offices provided the data on bus routes which were used for connectivity index.

The arrival of agricultural produce at different mandi yards has been taken from Agricultural Market committees, which keep regular records of daily, weekly, monthly and

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* Methodology of Nearest Neighbour Analysis (RN) :

$$RN = \frac{\bar{d}o}{\bar{d}E}$$

RN is the ratio of the actual mean distance between nearest neighbour points in a given area to the mean expected distance of random distribution of the same number of points in the same area. $\bar{d}o$ represents the actual mean distance between nearest neighbour points in a given area. $\bar{d}E$ is the mean expected distance of random distribution of the same number of points in the same area.

The Total Nearest Neighbour Distances = 502 kms.

Average Nearest Neighbour Distances = 502 ÷ 34 = 14.7

$$\bar{d}E = \frac{1}{2}\sqrt{\frac{A}{n}}$$ A is the area of territory being examined 'n' is the number of mandis located in the study area.

$$\bar{d}E = \frac{1}{2}\sqrt{\frac{12316}{34}}$$ A = 12316, n = 34.

$$\bar{d}E = \frac{1}{2}\sqrt{362.23} = \frac{1}{2} \times 19.03$$

$$\bar{d}E = 9.516$$

$$RN = \frac{\bar{d}o}{\bar{d}E} = \frac{14.7}{9.516} = 1.55$$

annual arrival of agricultural produce. The daily prices for all the commodities are also recorded there. The list of notified villages for each mandi was obtained from the Agricultural Marketing boards to demarcate notified areas for each regulated mandi.

The village level marketed surplus data has been collected from the 'Auction Registers' of the Market Committees. The register has detailed information about the sale of goods by each farmer, the quantity brought to the mandi, the price at which sold and the address of the farmer.

## 1.5 Methodology :

'Nearest neighbourhood technique has been used to observe the distribution pattern of the mandi points (market centres).

The road network structure has been studied on the basis of road maps and the mandi settlements' locations. The structural indices of the transport network are based on 'graph theoretic' concepts and methods. A composite index of transport network efficiency for different mandi hinterlands has been prepared by considering various structural indices. The nodality of mandi centres has been determined by preparing a composite index of indicators of nodal accessibility. The methods of preparing composite indices have been discussed in the concerned sections.

Simple annual growth rates have been calculated for the decade 1968-77 for the marketed surplus of 5 major agricultural commodities on the basis of which choropleth maps are prepared.

For the same five major commodities seasonal arrival patterns are analysed on the basis of average monthly arrival data for the year 1975-76. On the basis of twelve month's arrival data (monthly arrival as percentage to total annual arrival), these five major commodities are grouped into three

time periods*; (i) post-harvest period; (ii) intermediate period; (iii) and lean period.

All the mandis of the region are grouped in to different types by using McQuitty's Elementary Linkage Analysis.

A simple, and stepwise multiple regression has been used to see the nature of relationship between marketed surplus (dependent variable) on one side and the indices of transport network nodality of market centres (explanatory variables) on the other. The method has shown the contribution of each transport variable in explaining the variance in the arrival size of agricultural produce. Relative residuals from the simple regression and stepwise multiple regression have been plotted to know the regional disparities in the unexplained variance of marketed surplus.

With the help of choropleth maps, commodity wise mandi hinterlands have been delimited and the zones of agricultural marketing intensity identified for the selected mandis. For the same data and mandis, the regression lines are plotted to know how with the increase in distance from mandi centre, the arrival size declines. This hypothesis has been further discussed by drawing concentric zones, each at five miles radius from the mandi centre.

The simple graphic array of points has been used to distinguish different hierarchical orders of mandi centres and transport modes.

**1.6 Design of the Study :**

In Chapter I, the research problem has been introduced and brief account has been given to understand the region; its

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* Post-harvest period covers four months just after the harvest of crops. Lean period includes 4 months just before harvest. Intermediate period includes 4 remaining months of the year in between above two periods.

physiographic features, demographic characteristics and the levels of economic development. Methodology used and data base have been discussed very briefly, The later section contains the literature survey, from where the hypotheses are generated and listed at the end.

Further, an attempt has been made in Chapter II to describe the characteristics of transport network indices, which were derived on the principles of 'Graph-Theory'. On the basis of these indices levels of transport development has been determined. This chapter basically deals with two different aspects of transport network, viz., road network indices of mandi hinterlands and nodal accessibility of market centres. In both the sections composite indices are prepared to measure the levels of transport network development and disparities in the region.

Spatial structure of agricultural marketing is given in Chapter III. Annual and seasonal arrival patterns of agricultural marketed surplus are discussed in detail. In the end, mandis are grouped in different types.

Chapter IV describes the association between transport network structural indices and marketed surplus of agricultural produce. Here the transport network variables are taken as the explanatory variables. Marketed surplus of agricultural produce has been explained by transport network nodality indices.

In the Vth Chapter, agricultural marketed-surplus intensity-zones were discussed for the five selected mandis. Relationship between distance from the mandi centre, arrival size of marketed surplus and frequency of arrivals, are discussed.

Under Chapter VI, hierarchy of transport nodes and mandi centres has been established. Findings are summarised in Chapter VII. Appendices and selected bibliography follows next.

## LITERATURE REVIEW

Literature survey relates to following aspects of analysis :

### 1.7 Transport Network Studies :

The abundant published literature on transport network reveals that the studies were conducted broadly along the two main streams. One is the historical approach in which the evolution of transport routes[1] was analysed through different time periods. The second approach, which is more relevant to this study, is the analysis of the existing networks of transport The following discussion has covered in detail the literature along the latter approach.

Till 1960, most of the studies were descriptive in nature. Even after sixties the trend could change much slowly at least in India. Most traditional studies like Kulkarni (1955).[2] Bichitrananda Sinha (1957)[3], Ujagir Singh (1959)[4], Kayastha (1960)[5] and many others covered the general historical survey of roads, problems of different modes of transport,

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1. Some examples are Edward J. Taaffe, Richard L. Morrile, and Peter R. Gould. "Transport Evolution in Under Developed Countries: A Comparative Analysis", *Geographical Review*; Vol. 53 (1963), pp. 503-529. Andrew F. Burghartdt. "The Origin and Development of Road Network of the Niagara Peninsula, Ontario, 1870-1951." *Annals*, Association of American Geographers; Vol. 59 (1969), pp. 417-440. Sunil Kumar Munshi, *Geography of Transportation in Eastern India Under the British Raj* (*Calcutta : K.P. Bagchi & Company*, 1980).
2. L.Y. Kulkarni, "Communication in the State of Bombay". *Geographical Review of India*, Vol. XVII (1955), pp. 27-37.
3. Bichitrananda Sinha, "Transport and Communication Problems in Orissa". *Geographical Journal of India*, Vol. 3 (1957), pp. 27-45.
4. Ujagir Singh, "Growth of Transport and Communication in Allahabad". *The National Geographical Journal of India*, Vol. V (1959), pp. 186-204.
5. S.L. Kayastha, "Transport and Communication in the Himalayan Beas Basin". *The National Geographical Journal of India*, Vol. 6 (1960), pp. 105-114.

and emphasised the need of better road and railway network for the prosperity. Singh's (1967)[6] work, of course, is qualitatively much more different than the earlier contributors. He has tried to find out how far the existing lines of transportation are effective in the present spatial structure of economy in the areas so as to determine the magnitude of transportation requirements. The author has combined the rail and road accessibility. Somewhere else, he (Singh; 1970)[7] describes the efficiency of transport network and the determinants of network efficiency. The maps showing incidence of population per railway station and incidence of population on roads are interesting and informative in their own way.

A new trend was set in transport network studies from 1960 when Garrison (1960)[8] defined the topological properties of a graph and used them in his study of inter-state Highway system. Later, Kansky (1963)[9] further developed these graph theoretic concepts and methods. In this work, he related the structural indices (derived on the basis of graph theoretic measures) with regional characteristics. Haggett and Chorley (1968)[10] have given an exhaustive review of this approach in their monumental work. Now almost every standard book on transport geography includes graph theoretic concepts and measures. In India, Sinha and others (1971)[11]

6. D.N. Singh, "Accessibility in North Bihar". *The National Geographical Journal of India*, Vol. XIII (1967), pp. 168-180.
7. D.N. Singh, "Patterns of Transportation Links in Bihar—North of Ganga". *The National Geographical Journal of India*, Vol. 16 (1970), pp. 161-174.
8. William L. Garrison, "Connectivity of the Inter-State Highway System", Regional Science Association, *Papers and Proceedings*, Vol. 6 (1960), pp. 121-37.
9. K.J. Kansky, *Structure of Transportation Networks, Relationships Between Network Geometry and Regional Characteristics*, Geography Research Paper, University of Chicago, No. 84, 1963.
10. Peter Haggett and Richard J. Chorley, *Network Analysis in Geography*, (London : Edward Arnold, 1968), pp. 193-257.
11. B.N. Sinha and Others, "Accessibility of Roads in Mysore State", *The National Geographical Journal of India*, Vol. XVII (1971), pp. 77-89.

have also taken the help of topological properties of the road network of Mysore State (Karnataka). The network has been related with the economic development of the state. Ramachandran's (1981)[12] study of transport network structure is an attempt to correlate transport and urban attributes in Coimbatore region. Apart from using existing indices in the field, he developed some new indices in his study. Burgess (1976)[13] included descriptive properties like speed and safety to the already existing graph theoretic measures.

From a review of the literature, it appears that the graph theoretic measurements of connectivity of transport network have been largely used and that the techniques have yielded good results.

One also notes studies pertaining to transport hierarchy. Some of these are based on graph theoretic notions. Green (1953)[14] in his article has demarcated the hinterlands for different towns of Belgium, Netherland, West Germany and France on the basis of bus services. These urban hinterland maps speak of hinterland hierarchy in which different towns were arranged in different orders. Ullman (1960)[15] studied trade centres and tributary areas of the Philippines mainly on the basis of traffic flow and identified five types of centres in hierarchical order. The author also tried to explain how central place theory could be tested over here. Decey and others

12. H. Ramachandran, "Transportation and Urban Attributes—A Study of Structural Relations", *Annals*, National Association of Geographers, Vol. 1 (1981), pp. 48-68.

13. Bryan Eljah Burgess, "Method for Measuring Connectivity in Highway Transportation Network", (Ph. D. Thesis submitted in the University of Tennessee, 1976), Dissertation Abstracts, International Humanities and Social Sciences, Vol. 37, No. 2 (1976), pp. 1262-A to 1263-A.

14. F.H.W. Green, "Community of Interest Areas in Western Europe —Some Geographical Aspects of Local Passenger Traffic," *Economic Geography*, Vol. 29 (1953), pp. 283-98.

15. Edward Ullman, "Trade Centres and Tributary Areas of the Philippines", *Geographical Review*, Vol. 50 (1960), pp. 203-18.

(1961)[16] based on graph theoretic concepts, used intercity telephone calls data to determine the nodal structure of the cities. On the basis of degree of contact, various cities/nodal regions of Washington State were grouped in different hierarchies/orders. Taaffe (1962)[17] has compared the actual pattern of hinterlands with that of theoretical, based on gravity model. The hierarchy was determined by the air passenger linkages between different centres of United States. Dutt and others (1970)[18] have determined the central place hierarchy by a composite index, density of railway lines, density of railway stations, density of metalled roads and ratio of workers in transport, storage and communication to total number of workers for each Thana (area unit of study). Reed (1970)[19] in his paper has modified the technique of minimising the steps needed to exert direct and indirect dominance. Based on air-connectivity to each urban centre in India, the hierarchy of urban centres was decided for which Indian Air-Lines' data were used.

## 1.8 Studies on Marketing :

Before pointing out the studies which are geographical in nature, it would be interesting to recall the works which highlight the importance of marketing. Smith (1973)[20] studied that the efficient and organized marketing system provides consumers with improved products at lower costs, thus contributes positively to the development process. Chaudhry

16. John D. Nystuen and Michael F. Dacey, "Graph Theory Interpretation of Nodal Regions," *Papers and Proceedings*, Regional Science Association, Vol. 7 (1961), pp. 29-42.
17. Edward J. Taaffe, "The Urban Hierarchy : An Air Passenger Definition," *Economic Geography*, Vol. 38 (1962), pp. 1-14.
18. Ashok K. Dutt and Sanjay Banerjee, "Transportation Index in West Bengal : A means to Determine Central Place Hierarchy", *National Geographical Journal of India*, Vol. 16 (1970), pp. 199-207
19. Wallace E. Reed, Indirect Connectivity and Hierarchies of Urban Dominance", *Annals*, Association of American Geographers, Vol. 60 (1970), pp. 770-785.
20. Gordon W. Smith, "Marketing and Economic Development : A Brazilian case study, 1930-1970", *Food Research Institute Studies*, Vol. XII, No. 3 (1973), pp, 179-198.

(1970)[21] has noticed that the regulated markets have contributed a lot in changing subsistence farming into commercial farming in the Indian Sub-continent and have thus contributed to economic development. Harriss (1979)[22] noticed that the agricultural marketing system provides channels along which money commercializes. It provides economic impulses for both agriculture and manufacturing sector, for development. According to Nwokoye (1981)[23] marketing provides a driving force for economic development, and the level of economic activity in turn affects the development of the marketing system. Nwokoye as well as Drucker (1958)[24] have expressed that marketing is the process through which economy is integrated into society to serve the human needs.

Geographers have contributed a lot on periodic as well as on regular markets. Large number of studies on periodic markets like Pattanaik (1953)[25], Tamaskar (1966)[26], McKim (1972)[27], Jana (1978)[28] and many others, have described the commodities sold, the method of exchange, market size, their spatial and temporal distribution, their classification and hierarchical levels. Skinner's (1964-65)[29] work is a pio-

21. Ghulam Rasul Chaudhry, "Marketing Institutions and Economic Development", (Ph. D Thesis submitted at Kansas State University).
22. Barbara Harriss, "Going Against the Grain" *Development and Change*, Vol 10 (1979), p. 364.
23. Nouveliu G Nwokoye, *Modern Marketing for Nigeria*, (London : The McMillan Press Ltd, 1981) pp 6-7.
24. Peter F Drucker, "Marketing and Economic Development", *Journal of Marketing*, Vol 22, (1958), p 25 .
25. Nityananda Pattanaik, "Study of the weekly Market at Barpati", *Geographical Review of India*, Vol. XV (i), 1953, pp. 19-31.
26. B G Tamaskar, "The weekly Markets of the Sagar-Damoh Plateau", *The National Geographical Journal of India*, Vol. 12 (i), 1966, pp 38-50
27. Wayne McKim, "The Periodic Market System in North-eastern Ghana", *Economic Geography*, Vol. 48 (1972), pp. 333-344.
28. M.M. Jana, "Hierarchy of Market Centres in Salabati Basin", *Geographical Reviews of India*, Vol. 40 (1978). pp. 164-174.
29. G.W. Skinner, "Marketing and Social Structure in Rural China", *Journal of Asian Studies*, Vol. 24 (1964-65), pp. 195-228 and 363-99.

neering theoretical work, where author has tested the central place model in rural China. The author discussed how these markets established the socio-economic dimensions of rural life.

Relatively little attention is paid towards the specific study of agricultural mandis/markets. Neale and others' (1965)[30] report on Kurali market is one of the exhaustive and earliest studies in which authors have analysed the agricultural marketing structure of a regulated mandi. Role of market centres/regulated mandi towns in the development process is one of the basic themes of many of the articles presented in the NCAER (1972)[31] volume. Harriss' (1974)[32] work on Punjab wheat markets deals with the spatial distribution, size and structure of mandis and the settlements. The author successfully distinguished the central place hierarchies and mandi hierarchies. Potential growth centres were identified. Problems related to shape and size of the tributary areas were discussed. Employment characteristics of the wholesale firms and the influence of mandi towns on the rural surroundings were analysed. Smith (1975)[33] has studied the processes and channels through which commodities are exchanged between agricultural producers and the urban consumers in Quito, Pichincha province. Organization of market system, supply areas and variations in the interconnectivity by function has been discussed. Banerjee (1977)[34] has studied the regional structure of

30. Walter C. Neale, Harpal Singh and Jaipal Singh, "Kurali Market—A Report on the Economic Geography of Marketing in Northern Punjab", *Economic Development and Cultural Change*, Vol. XIII (1965), pp. 129-68.
31. NCAER, Market Towns and Spatial Development (New Delhi: Sree Saraswaty Press Ltd., 1972).
32. Barbara Harriss, "The Role of Punjab Wheat Markets as Growth Centres", *Journal of Geography*, Vol. 73 (1974), pp. 52-71.
33. Vernon Smith, "Marketing Agricultural commodities in Pichincha Province, Equadore," *The Geographical Review*, Vol. 65 (1975), pp. 353-363.
34. Mala Banerjee, *Regulated Market Centres and their Hinterlands: A Spatial Study of Haryana*, M. Phil Dissertation, submitted at CSRD, JNU, New Delhi, 1977.

the marketing of agricultural produce in Haryana state. She has delineated mandi hinterlands and described their regional characteristics.

## 1.9 Transportation and Marketing :

Efficient and improved transport system is one of the most important factors in the agricultural development of a region. Abbott (1962)[35] also discussed that agricultural production is generally limited to the needs of local village markets until low-cost transport facilities make other outlets accessible. Higher farmstead prices for agricultural products which accompany improved transport and marketing facilities, encourage specialization in cash crop cultivation (Liang).[36] Kulkarni (1956)[37] considered transportation and marketing as the integral part of each other. Weakness or strength of marketing depends on the level of transport efficiency. The agricultural production is characterised by perishability, seasonality and bulkiness. Under such conditions, Nichols (1969)[38] expressed that a dependable and flexible transport system is required. Transport rate structure has been largely effected by the improvement in transport technology. Which has ultimately influenced the location of markets and producing areas.

Lauth (1969)[39] adds that highly developed transportation

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35. J.C. Abbott, "The Role of Marketing in the Development of Backward Agricultural Economies," *Journal of Farm Economics*, Vol. 44 (1962), pp. 349-62.
36. P.P. Ernest Liang, "Market Accessibility and Agricultural Development in Pre-War China", *Economic Development and Cultural Change*, Vol. 30 No. 1, (1981).
37. K.R. Kulkarni, *Agricultural Marketing In India*, Vol. I, 5 (Bombay, Somaiya Pub. Pvt. Ltd., 1956).
38. J.E. Nichols, Jr. "Transportation and Regional Development in Agriculture", *American Journal of Agricultural Economics*, Vol. 51 (1969), pp. 1455-63.
39. James H. Lauth, "Economic Considerations in Rate Making and Rate Structures for Farm Products", *American Journal of Agricultural Economics*, Vol. 51 Part 2, (1969), pp. 1464-1470.

system eliminates the need to produce our food products very near to the settlement locations. It has, rather permitted high degree of regional specialization of farm production. Leaman and Conkling (1975)[40] pointed out that the improved transport technology has reduced the gap between producer and consumer, which has resulted in greater regional specialization of production and inter-regional trade in agricultural commodities. Authors tested that a prolonged period of falling transport costs is associated with increasing regional specialization of agriculture.

Anderson (1970)[41] observed that the road system built during 1960's had been the greatest single spur to the Thai marketing, distribution, pricing and consumption patterns.

Smith (1972)[42] based his study on the notion that economic stratification in traditional societies is structured in space, and influenced by the pattern of market access. He observed that the income of the under developed countries is distributed through the system of marketing and the regional pattern of economic growth has much to do with the organization of trade and markets.

Saxena (1975)[43] made an attempt to investigate into the system of transportation and market centres and their mutual relationship in the Hadaoti Plateau of South-eastern Rajasthan.

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40. J. Harold Leaman and E.C. Conkling, "Transport change and Agricultural specialization", *Annals*, Association of American Geographers, Vol. 65 (1975), pp. 425-432.
41. Dole A. Anderson, *Marketing and Development : The Thailand Experience*, (East Lansing : Michigan State University, Bureau of Business and Economic Research, 1970), Chap. 4.
42. Carol A. Smith, "Market Articulation and Economic Stratification in Western Guatemala", *Food Research Institute Studies in Agricultural Economics, Trade and Development*. Vol. XI (1972), pp. 203-233.
43. H.M. Saxena, *Geography of Transport and Market Centres*, (New Delhi : S. Chand & Co., 1975).

After going through the literature on transport network studies and agricultural marketing, one observes certain unanswered questions. There are numerous topological studies on transport-network where relationship has been established between structural indices and the regional or economic characteristics of different regions. But the studies where transport network structural indices are studied in relation to agricultural marketing characteristics are but few.

A critical evaluation of the literature cited above and other relevant literature in the field has led to the development of the following hypothesis :

**1.10 Hypotheses Generated :**

1. Transport network efficiency plays an important role in determining the size of agricultural marketed surplus. Hence, better the network system of the mandi hinterlands, larger the marketed surplus.
2. If the mandi towns/settlements can dispose of the market arrivals efficiently and quickly, more and more arrivals will be encouraged. Hence, higher the accessibility of individual mandi nodes, larger will be the marketed surplus.
3. Transport development explains the agricultural marketing disparities up to great extent. Hence, larger the variations in transport network efficiency of the mandi hinterlands or nodal accessibility, larger would be the disparity in market arrivals.
4. The actual mandi hinterlands are comparable with the notified mandi hinterlands in form.
5. The intensity of agricultural market arrivals decreases with distance from the market centre uniformly in all directions, i.e., the inner most zone has maximum intensity of arrivals. The arrival intensity decreases with the increasing distance from the mandi centre.

6. With an increase in distance, the number of sellers decreases. Hence the frequency of arrivals declines.
7. As the distance from a mandi centre increases, the arrival of market surplus is reduced but the quantity received in each trip tends to increase (large average arrival size).
8. Better road accessibility would increase the intensity of total arrivals. The villages located along the roads, which lead towards the mandis, assure more arrivals and farmers bring their produce more frequently.
9. There is a system of hierarchical grouping of centres among transport nodes and market nodes. In general, the hierarchy of centres based on nodal accessibility should coincide with the hierarchy based on the arrival size.

# 2

# Transport—Network Structure

## 2.1 Introduction :

This chapter brings out the salient characteristics of the structure of transport-network and the distribution of settlements vis-a-vis transport lines. The chapter is divided into four sections. Section I highlights the salient features of road-network. In section II, connectivity of the mandi hinterlands is measured by the simple principles of graph theory. Section III relates to the analysis of the accessibility of regulated mandis via roads and railways. Section IV describes the intra-mandi and inter-mandi linkages.

## 2.2 Methodology :

The analysis of transport network development in this section is based on graph theory. As discussed earlier, Garrison (1960)[1] was the first to define the topological properties of a graph and used graph theory in his study. Later on his student Kansky (1963)[2] further developed those concepts and methods.

1. William L. Garrison, "Connectivity of the Inter-state Highway System", Regional Science Association, *Papers and Proceedings*, Vol. 6, (1960), pp. 121-37.
2. K.J. Kansky, "Structure of transportation Networks, relationships between network geometry and regional characteristics", University of Chicago, Geography Research Paper, 84 (1963).

Graph theory provides the language to define the topological properties of the network. Graph theoretic measures of network structure can be derived if we simplify the transport network into a graph. The ordinary graph which represents the transport system of network is characterised by the following properties :

(1) Every transport network system has certain places. Each crossing of routes or terminus is considered as vertex (v).

(2) Each route is a set consisting of two places. The route joining the two vertices is called an edge (e).

(3) Only one route may join a pair of places.

(4) Number of subgraphs or subsidiary networks are denoted by p.

With the help of topological measures derived from graph theory, we can understand as to how well connected is the network viewed as a whole and how well connected is each individual point with every other point in the network. Both these notions have been tested in the forthcoming sections of this chapter for mandi hinterlands and mandi centres.

In order to study the transport network efficiency of mandi hinterlands, the following ratio and non-ratio graph theoretic measures have been taken up and discussed.

1. Cyclomatic Number ($\mu$)
2. Alpha ($\alpha$)
3. Beta ($\beta$)
4. Gama ($\gamma$)
5. Eta ($\eta$)
6. Theta ($\theta$)
7, Road Density* (*Dn*)

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* The road density indicator is not based on graph theory.

Their definitions, mathematical formulations, properties and spatial description have been given in the Section-II. At the end of Section II, these structural indices are taken up for compositing together. Mean value has been calculated for each indicator. The values of all the indicators for each mandi-area were divided by their respective mean values except Fta Index. This is a negative indicator, where the mean value has been divided by the actual figures. Thus we arrived at new figures which were scale free and added up all the scale free values. By this process we got the composite index, which has been discussed under heading, 'The levels of transport network development', in Section II.

Under section III the following indices of nodal accessibility (based on graph theory) of individual mandi points have been analysed and the method of their calculation is given at the relevant places :

1. Local degree (road)
2. Local degree (railways)
3. Weighted road capacity
4. Direct connectivity by bus routes
5. Tortuosity of routes
6. Aggregate travel distance

Lastly in Section III, the above indicators of mandi nodality have been composited together and the regional disparities in nodal accessibility are described for the region. Because of the non-comparability of the indicators of accessibility, the mandi wise values for all the indicators have been made scale free by dividing these values with their respective means, except aggregate travel distance which is a negative indicator where mean has been divided by actual values for different mandis. After making all these parameters scale-free we added the scale free products for all mandis to get the composite value which will represent the nodal accessibility.

The last section, Section IV deals with Settlement linkages within the mandi hinterland and inter-mandi-area settlement linkages, which are based on direct bus routes. In order to study settlement linkages within the mandi-areas, nxn matrices have been prepared for all the settlements along the roads for every mandi hinterland, where each linkage is given the value of one and from where a composite value for bus-connectivity has been calculated thus giving observed connectivity (c) of settlements along the roads. The observed connectivity is different from the optimum connectivity which is calculated as n(n—1) where n stands for the total number of settlements, where every settlement would be connected with all other settlements. This ratio between the observed connectivity and the optimum connectivity would gives the required linkage values. The following is the mathematical formulation :

$$L = \frac{c}{n\,(n-1)}$$

where L stands for index of linkages

c stands for observed linkages

n stands for total number of settlements within the mandi hinterland.

Inter-mandi-hinterland bus connectivity linkages have been calculated by summation of direct connections of villages of one mandi-area to the villages of another mandi-areas. Afterwards, its ratio has been calculated to the maximum possible connections in two given mandi-areas, which may be calculated by following formula :

$$\frac{L1}{(V1 \times V2}$$

$L_1$ stands for observed inter-mandi-hinterland bus linkages

$V_1$ stands for number of vertics in a mandi-area

$V_2$ stands for the number of vertics in another mandi hinterland.

Lastly, the chapter ends by summarising the findings.

## SECTION—I

### 2.3 Salient Features of Road Network :

The attached road map (No. 2.1) shows that the region has different types of road networks, ranging from very simple to complicated ones. The whole northern part of the region appears like a thick net of roads. Further south, some abrupt change in the road network are noted, particularly in case of mandi hinterlands of the districts of Jaipur and Alwar, which have very poor transport network. The area along Aravalli range has very poor network system. In Amber, Thanagazi, Jamwa Ramgarh, Behror, Dausa and Sikri regions, the road network is very poor and the settlements are sparsely distributed which is an obvious effect of physiography.

The road network shows that in the notified areas of some mandis, the road system appears to be poor as it is a broken one, does not link roads with each other and hence the chances of interaction are minimum. The radial type of road network of Agra and Rewari shows the importance of these focal points. Generally, the roads are centred around those mandis which are also the tehsil headquarters.

The road network of Tijara tehsil shows that there are good number of roads which are linked to the main roads but they do not contribute much to the structural efficiency of the network system. This type of system is not supposed to be good one because here the degree of inter-connectivity is very low. The network system which has maximum number of triangles, rectangles, squares or any type of such shapes contributes much to the efficiency of road network in the region. It is because such types of road connections make the circuits which lead to maximum interactions.

### 2.4 Settlements and Transport Network :

The Delhi-Jaipur-Agra triangle has 7448 settlements and 30 urban settlements. In this section, a brief introduction has been given to their distance from the metalled roads.

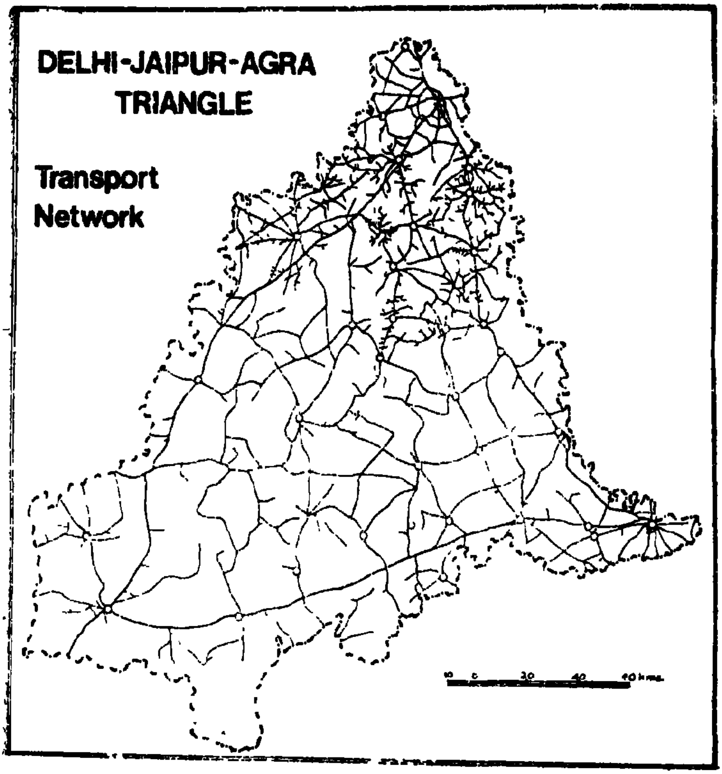
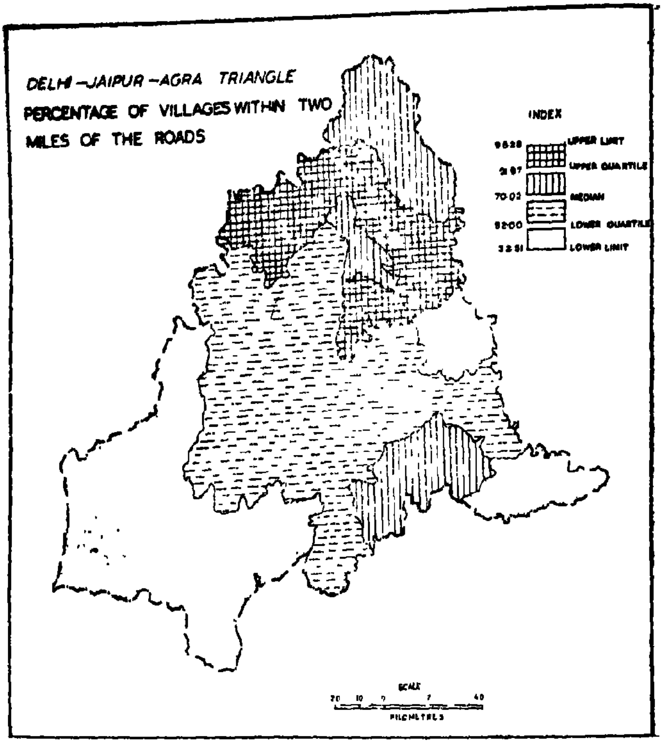



Fig. : 2.1


DELHI –JAIPUR –AGRA TRIANGLE
PERCENTAGE OF VILLAGES WITHIN TWO
MILES OF THE ROADS
INDEX
UPPER LIMIT
UPPER QUARTILE
MEDIAN
LOWER QUARTILE
LOWER LIMIT
SCALE

I ig. : 2.2

The settlements in this region are highly accessible with respect to roads. Nearly 63 per cent of the settlements are within a distance of 2 miles from the roads. However, there are large variations in mandi hinterlands with respect to the percentage of settlements which are within 2 miles from the roads. These percentages vary from 32 in Kosi to 96 in Ferozepur Jhirka (Table No. 2.1). In northern part of the region (in all the mandi hinterlands of district Gurgaon and Delhi) more than 90 per cent of the settlements are within two miles from the roads (Map No. 2.2). Most of the mandi hinterlands which have less than 50 per cent villages within two miles from the roads fall in the south-western part of the region and make a contiguous belt over uneven topography. About 70 per cent of the mandi hinterlands of the region have more than 50 per cent settlements within 2 miles from the roads.

**Table 2.1**

**Road Accessibility**

| *S. No.* | *Name of the mandi* | *Percentage of villages within two miles of the roads* | *Percentage of villages 2-4 miles away from the roads* | *Percentage of villages more than 4 miles away from the roads* |
|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* |
| 1. | Najafgarh | 91.97 | 8.03 | — |
| 2. | Narela | 90.01 | 9.09 | — |
| 3. | Sohna | 94.64 | 5.35 | — |
| 4. | Gurgaon | 94.64 | 5.35 | — |
| 5. | Rewari | 94.82 | 5.17 | — |
| 6. | Ballabgarh | 89.65 | 10.34 | — |
| 7. | Hodel | 93.90 | 6.09 | — |
| 8. | Palwal | 93.90 | 6.09 | — |

*(Contd. on next page.)*

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 9. | Nuh | 90.65 | 9.34 | — |
| 10. | F.P. Jhirka | 96.28 | 3.71 | — |
| 11. | Kosi | 32.51 | 52.14 | 2.22 |
| 12. | Mathura | 57.52 | 40.26 | 2.22 |
| 13. | Bharatpur | 83.87 | 24.47 | 1.76 |
| 14. | Nadbai | 81.57 | 14.03 | 4.40 |
| 15. | Bhusawar | 89.40 | 10.59 | — |
| 16. | Kaman | 66.27 | 33.73 | — |
| 17. | Nagar | 63.37 | 30.61 | 6.02 |
| 18. | Deeg | 63.02 | 32.77 | 4.21 |
| 19. | Mahwa | 55.92 | 44.08 | — |
| 20. | Jaipur | 52.00 | 43.00 | 5.00 |
| 21. | Chomu | 47.24 | 34.40 | 19.36 |
| 22. | Dausa | 40.41 | 57.08 | 2.51 |
| 23. | Bandikui | 34.52 | 47.61 | 17.97 |
| 24. | Kotputli | 42.62 | 42.62 | 15.76 |
| 25. | Alwar | 57.98 | 37.64 | 4.38 |
| 26. | Khairthal | 57.65 | 42.35 | — |
| 27. | Kherli | 54.20 | 44.54 | 1.26 |
| 28. | Agra | 40.60 | 59.39 | — |
| 29. | Kirauli | 39.64 | 60.35 | — |
| 30. | Punahana | 96.28 | 3.71 | — |
| 31. | Tauru | 90.65 | 9.34 | — |
| 32. | Pataudi | 94.82 | 5.17 | — |
| 33. | Achhnera | 40.60 | 59.39 | — |
| 34. | Faridabad | 89.65 | 10.34 | — |

Nearly 32 per cent of the settlements of the region are at a distance of 2 to 4 miles away from the roads. Ferozepur Jhirka and Punahana mandis have only 3.71 per cent (minimum) of settlements in the belt of 2 to 4 miles away from the

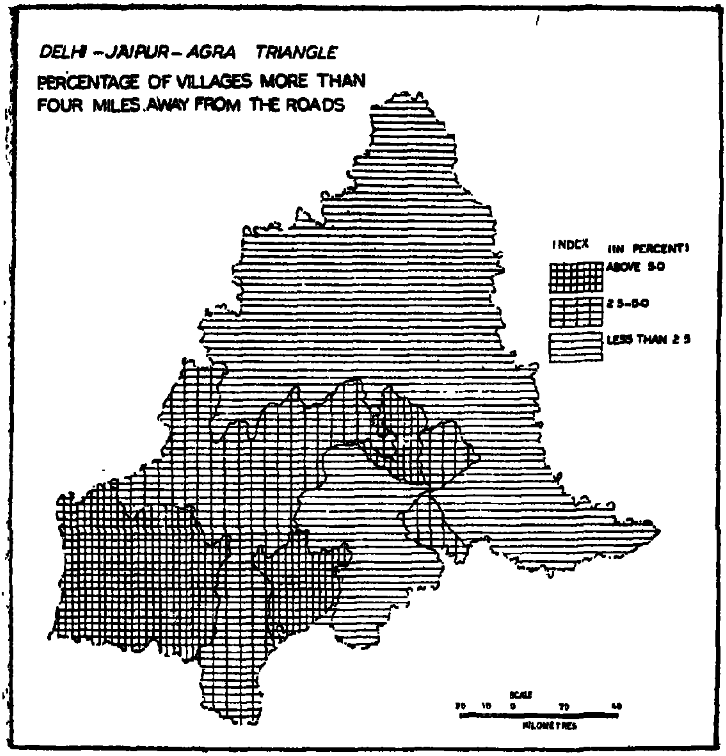

DELHI –JAIPUR– AGRA TRIANGLE
PERCENTAGE OF VILLAGES MORE THAN
FOUR MILES AWAY FROM THE ROADS
INDEX (IN PERCENT)
ABOVE 5.0
2.5–5.0
LESS THAN 2.5

Fig. : 2.3

roads (Table No. 2.1). Kirauli, Achhnera and Fatehpur Sikri have 60.35 per cent (maximum) of the settlements within a distance from 2 to 4 miles from the roads. There are only six mandi hinterlands where more than 50 per cent villages fall within a distance of 2-4 miles from the roads. These mandi areas don't make contiguous region and are scattered in southwest, midsouth, southeast and eastern part of the region.

Hardly 5 per cent of the settlements of the region are located more than 4 miles away from the roads. Mandi areas of district Gurgaon and Delhi in the north, Achhnera, Fatehpur Sikri and Agra in southeast do not have any village which is more than 4 miles away from the roads. The percentage values range from 1.74 in Bharatpur mandi area (minimum) to 18.34 in Chomu (maximum). In the mandi hinterlands in south-western part of the region (the areas which have hilly and forested topography), the percentage of villages which are more than 4 miles away from the roads is higher, ranging from 4 to 18 per cent (Map No. 2.3).

## SECTION—II

### 2.5 Connectivity :

An efficient road network stimulates the mandi hinterland villages to transport their marketable surplus to the mandi-yard. In this section, thus a large number of variables of transport network development have been studied individually and together to understand the efficiency of the existing road network in the region as given below :

#### 2.5.1 Cyclomatic Number : ($\mu$)

This is a fundamental index (non-ratio) of the graph-theory. The cyclomatic number indicates the number of circuits (circuit is a path where one starts from a particular place known as vertex, and comes back to the same vertex

without crossing any of the edges more than once) in a network. This may be calculated by the following given formula :

$$\mu = e - V + p$$

Where 'e' stands for edge,
'V' stands for vertex and
'p' stands for sub-graph.

The greatest drawback of this index is that it does not consider the shape and size of the region. For example, it is economical to connect an alongated region in a linear form. If the vertices are more, possibly the circuits also may be more, thus the comparison of two different sizes of network is not possible.

According to this index, the mandi notified-areas which have disconnected or tree shaped road network, have zero cyclomatic number. On the other hand, the mandi hinterlands which have highly connected road networks, have a high score for $\mu$. In other words, a disconnected graph has a zero cyclomatic number, whereas, as the graph moves closer and closer to the completely connected state, the cyclomatic number increases. If we apply this notion to the structure of transportation networks, it is quite possible to hypothesize that the magnitude of the cyclomatic number which characterises a region's transportation system, would bear a direct-relationship with the levels of development for a given region.[3]

The attached Map No. 2.4 in which cyclomatic numbers have been depicted, explains one of the structural characteristics of the road network. A large number of mandi areas do not possess even a single circuit. There is continuous area starting from Kosi-Kalan in mid north-east to Dausa in south-west where the mandi areas are deprived of cyclomatic number, meaning thereby a poor network structure and lack of interconnections. At both the ends on the western side of this poor zone, there are two other pockets of this category. As per size-biasness of the index, the largest mandi areas must have highest

3. W.L. Garrison and D.F. Marble, "Graph Theoretic concepts" in Eliot Hurst and E. Michel (eds.), *Transportation Geography—Comments and Readings* (New York, McGraw Hill, 1974), p. 64.

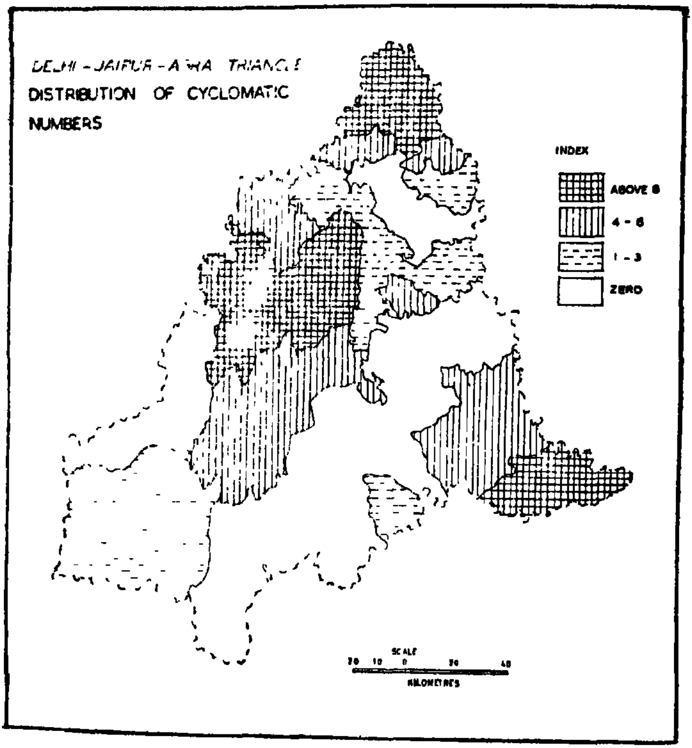

DISTRIBUTION OF CYCLOMATIC NUMBERS
INDEX
ABOVE 8
4 - 8
1 - 3
ZERO
SCALE
KILOMETRES

Fig. : 2.4

cyclomatic numbers. But this is not well demonstrated in this region. For instance, Jaipur and Alwar mandis have almost largest size of notified-areas. Even Jaipur comes in the low category. More than 50 per cent of the Haryana mandis of the region fall under poor (third) category because they are small in size, though they have high road density. The average value for cyclomatic number is 2.35. Rewari, Delhi, Gurgaon, Faridabad, Khairthal, Bharatpur, Agra, Mathura, Alwar and Punahana come above average. The mandi-areas which have highest number of circuits are Delhi (state), Khairthal (8) and Agra (7), having sufficiently larger areas. The mandis which come under medium category are highly scattered over the region. Most of the mandis along the Aravalli range have a larger command area, meaning thereby, that they have a poor market network.

**2.5 2 Alpha (α) :**

Alpha (α) is the ratio between actual number of circuits and total maximum possible circuits in any area. It is an adjusted form of cyclomatic number. This may be calculated with the help of following formula :

$$\alpha = \frac{e - v + p\ (\mu)}{\frac{V\ (V-1)}{2} - (V-1)}$$

In the equation $\mu$ denotes actual number of circuits and V stands for Vertex. The denominator is equal to the total maximum possible circuits in the region. Since the Alpha index[4] has been derived from cyclomatic number, all those mandi-areas which do not have any circuit are also deprived of the alpha score. In alpha index, the connectivity values may range from zero to one. For completely interconnected network (i.e. maximum number of edges), the value will be one. A value 1.00 prevails in a situation in which every possible link

4. W. Garrison and D. Marble, The Structure of Transportation Networks (Washington, D.C. : U.S. Department of Commerce, Office of Technical Services, 1961), p. 37.

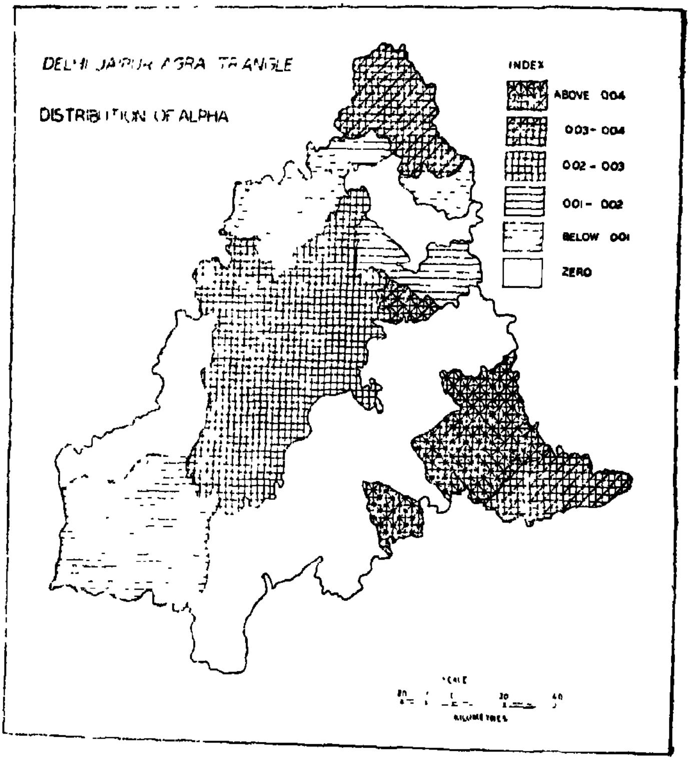

DELHI JAIPUR AGRA TRIANGLE
DISTRIBUTION OF ALPHA
INDEX
ABOVE 004
003 - 004
002 - 003
001 - 002
BELOW 001
ZERO

Fig. : 2.5

exists between the various nodes.[5] Besides, transport network which has 1.00 alpha value that means it has maximum possible circuits and arcs, which indicates the maximum degree of connectivity. If the alpha index values are multiplied[6] by 100, the values obtained from 0 – 100 can be interpreted as the percent of maximum connectivity. As the number of edges decreases, the connectivity values decrease towards zero. The value will be zero for the network which has no circuit. Thus the index is independent of the number of vertices in the network. The advantage of this index is that two networks of unequal sizes can also be compared.

The average alpha value for the region is 0.0016. The mandi hinterlands have alpha value above average of the region. The notified mandi hinterlands of Mathura, Bharatpur, Punahana and Bhusawar have very high ratio of circuits and total maximum possible route circuits i.e. 0.0086, .0071, .0048 & .0041 respectively (Map No. 2.5). This part of the region is nearer to the optimal desired road network structure. Rewari, Pataudi and Ballabgarh are emerging out with poor network on the Map No. 2.5 with alpha values : .00085, .00075 and .00022 respectively. Jaipur, Hodel, Gurgaon and Nuh are slightly in better position. Further developed transport network is that of Faridabad, Agra, Khairthal, Ferozpur Jhirka, Tauru and Alwar, with alpha values ranging from. .00387 to .00210. Generally, the mandi-areas which have high number of cyclomatic number also have high score of alpha index.

### 2.5.3 Beta ($\beta$) :

This index has been taken to express the relationship between edges and vertices. Mathematically it can be expressed as Beta = $\frac{e}{v}$, e denotes edges and v stands for vertices. '$\beta$' for developed network will have higher values. Tree like or

5. H. Robinson and C.G. Bamford, *Geography of Transport*, (London : McDonald and Evans, 1978).
6. As recommended by Garrison and Marble, *op. cit.*, p. 39.

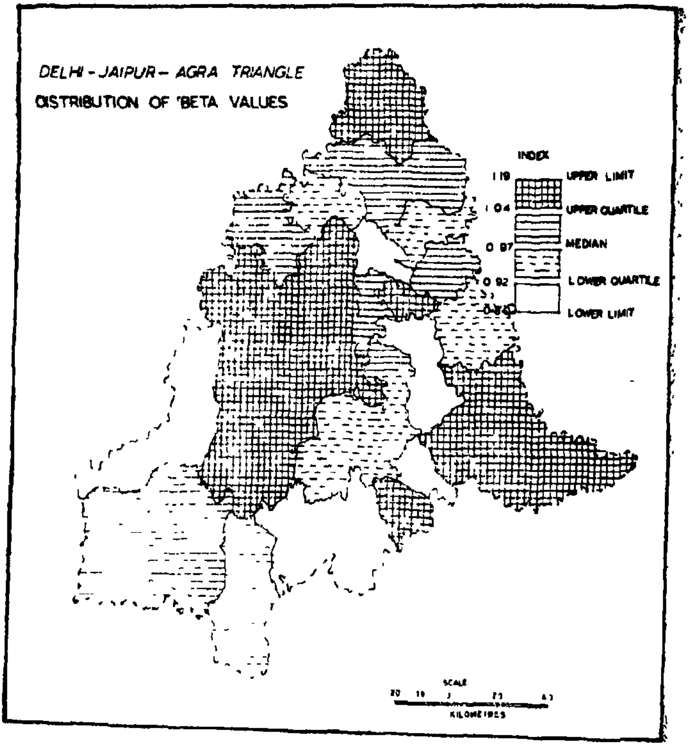

DELHI - JAIPUR - AGRA TRIANGLE
DISTRIBUTION OF 'BETA VALUES
INDEX
1 19
UPPER LIMIT
1 04
UPPER QUARTILE
0 97
MEDIAN
0 92
LOWER QUARTILE
LOWER LIMIT
SCALE
KILOMETRES

Fig. : 2.6

disconnected network will have less value. Better developed network has a value more than unity. This index has three properties[7] : (i) trees and disconnected graphs have values <1; (ii) a value of one is given to any network which has only one circuit, (iii) higher value in the 'β' index are produced by a complicated network structure, with the high number of vertices Map No. 2.6 shows the variations in the ratio of edges and vertices, The average beta value for the region is .9837. Twenty mandi hinterlands have beta values above average and eleven hinterlands fall below average. The maximum edges per vertex were recorded in Delhi 1.194 followed by Bharatpur mandi hinterland 1.086, Sohna represents the medium value i.e. .970. The lowest edges-vertices ratio goes down upto .8 for Chomu notified mandi area. The beta values plotted on the map do not give clear cut zones. Rather these are fragmented and occupy distant parts of the region. Most of the north, mid-west and south-east comes under first or second quartile (most developed ones). The mandis which have poor transport development cross the region from mid south-west to north-east. Nuh, Bandikui, Kotputali, Nadbai, Deeg, Kama, Mahwa and Chomu mandi areas have beta values from .913 to .800 and fall in the fourth quartile. Most of these mandis are also not important from the point of view of commodity arrivals. Though, Alwar and Khairthal mandi-areas are quite rugged in topography, they have better network of transport lines as reflected by the beta index. If one travels from Agra to Jaipur or from Jaipur to Delhi over the National Highway, one passes through the mandi areas of all four categories (see Map No. 2.6).

**2.5.4 Gama (γ) :**

This index has been taken to show the ratio between edges and total possible edges in a network.

7. K.J. Kansky, "Structure of Transportation Network", University of Chicago, Department of Geography, Research Paper No. 84. (1963), p. 16.

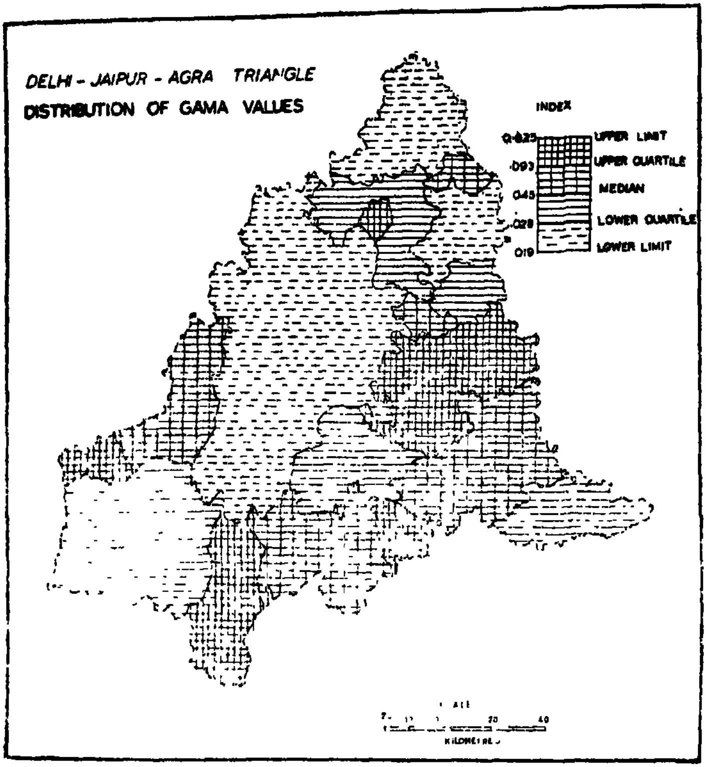

DELHI - JAIPUR - AGRA TRIANGLE
DISTRIBUTION OF GAMA VALUES
INDEX
.093
045
.028
019
UPPER QUARTILE
MEDIAN
LOWER QUARTILE
LOWER LIMIT

Fig. : 2.7

The gama index may be expressed with the given formula :

$$\gamma = \frac{e}{\frac{V(V-1)}{2}}$$

'e' and 'v' stand for edges and vertices respectively. Since gama index is relative, its comparison between two networks is possible. The values of this index varies from zero to one. The most developed transport network will have gama value one. In other words, index value one will be assigned to all the completely connected networks irrespective of the number of vertices they have. Thus index is independent of vertices of transport network. This index may also be written in percentages.

The average gama index value for the region is .0830. The mandi hinterlands which have lowest gama values lie almost in the northern and mid western part of the region (Map No. 2.7). In mid-west, it makes a continuous zone extending over Alwar, Khairthal, Ferozepur-Jhirka and Rewari, which is adjacent to Aravalli hills. None of these mandis have gama value more than .0277. Rewari represents the lower limit of gama index (.019) and Tauru upper limit with .6250 as gama value for the notified area of this mandi. Deeg, Chomu, Kaman, Kosi, Nagar and Bhusawar are the other parts of the region which have relatively higher ratio. For Faridabad mandi area, the gama value is .0453 which represents the medium figure in the distribution. Jaipur, Agra, Mathura, Bharatpur are very big mandis but have medium gama values for their hinterlands.

### 2.5.5 Eta ($\eta$)

This is the ratio between total road mileage of an area and total number of edges in that area. It is the average length of an edge, Eta ($\eta$) may be expressed as $\eta = \frac{m}{e}$, where 'm' denotes total mileage of the network and 'e' stands for edges.

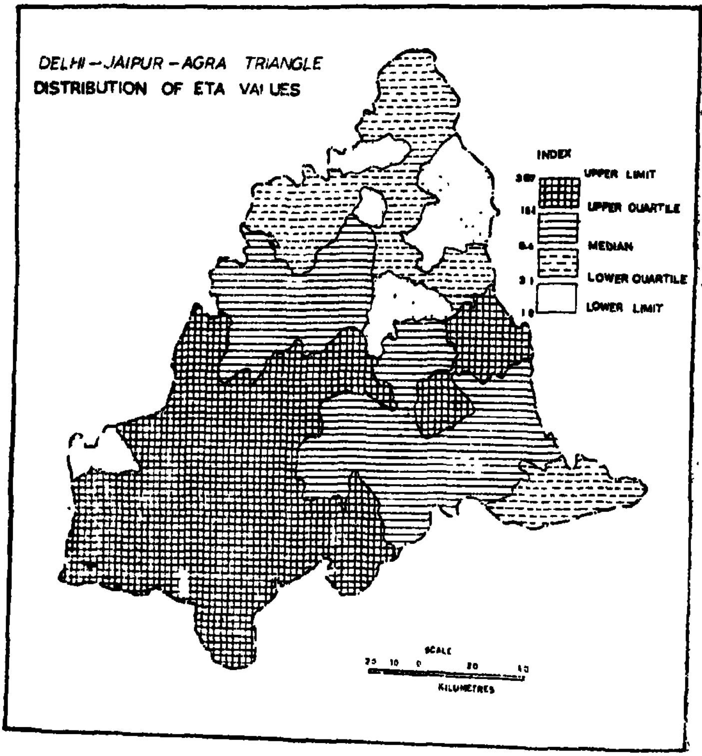

DELHI—JAIPUR—AGRA TRIANGLE
DISTRIBUTION OF ETA VALUES
INDEX
UPPER LIMIT
UPPER QUARTILE
MEDIAN
LOWER QUARTILE
LOWER LIMIT
SCALE
KILOMETRES

Fig. : 2.8

The major drawbacks are (i) it does not take into account the number of vertices hence it is subject to size variation; (ii) it is dependent on the pattern of spatial distribution of vertices. As more urban centres are included as nodes on the transportation network, lower numerical values of $\eta$ appear. Thus it is a negative indicator. Higher value of Eta indicates lower development of transport network and vice versa.

Eta values plotted mandi area-wise in the attached map (Map No. 2.8) give some interesting patterns. A large continuous area extending towards south-western part of the region has poorest network, because it has highest eta values. The average value for the eta index is 10.96. Out of 31 mandis 13 have eta index value above average. These are Jaipur, Kotputli, Khairthal, Dausa, Bandikui, Mahwa Mandawar, Mathura, Kosi, Deeg, Kaman, Nagar, Kherli and Alwar with eta index values 28.61, 29.6, 14.44, 36.70, 21.6, 17.45, 11.76, 25.00, 23.11, 13.14, 13.17, 13.91 and 15.91 respectively. Remaining 18 mandi hinterlands have eta index value below average ranging from 10.73 index value to 1.78. Dausa notified mandi area has the highest (36.70) eta value, which shows that its road network development is least developed. Going further north-east is slightly a better zone, crossing the heart of the region from north west to south-east. Delhi and Haryana have less eta values and hence the whole of northern part of the region has developed road transport network. In Ferozepur-Jhirka mandi catchment area, the average size of an edge is 1.788 km., the lowest figure in whole of the region. This reality brings this mandi-area in the first rank of road network development.

**2.5.6 Theta** ($\theta$) :

Theta represents the average length of edge per vertex. This is the ratio of network as a whole to its vertices in any given area. It may be calculated as $\theta = m/v$ where m stands for total road mileage in the mandi hinterland and v stands for number of vertices in the same hinterland. Its main property is that it offers information about length, structure and also on the degree of connectivity simultaneously. The

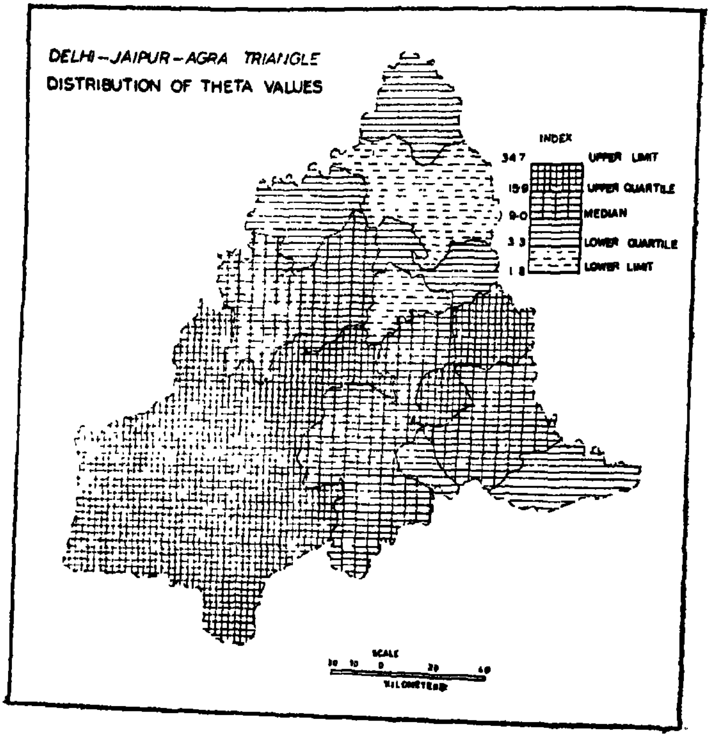

DELHI–JAIPUR–AGRA TRIANGLE
DISTRIBUTION OF THETA VALUES
INDEX
34.7 UPPER LIMIT
15.9 UPPER QUARTILE
9.0 MEDIAN
3.3 LOWER QUARTILE
1.8 LOWER LIMIT
SCALE
0

Fig. : 2.9

disadvantage is that the comparison is not possible when the networks of the regions have different shapes, and distribution of vertices is different.

If we analyse the transport network with the help of Theta index, disparities are comparatively more. Theta values range from 1.79 (for F.P. Jhirka), minimum, to 34.67 (for Dausa) highest. The average theta value for the region is 11.01. Jaipur (28.45), Chomu (16.9), Kotputli (26.90), Khairthal (15.22), Dausa (34.66), Bandikui (19.63), Mahwa Mandawar (14.76), Bharatpur (11.65), Mathura (12.5), Kosi (23.52), Deeg (20.8), Kaman (11.5), Nagar (12.44), Kherli (13.06) and Alwar (16.62) are the mandi hinterlands which have theta index value above average. For the remaining 16 mandi hinterlands which fall below average, the theta value range from 11.5 for Kaman to 1.79 for Ferozepur Jhirka. A large area in south-west makes contiguous region of high Theta values. The mandi-areas which have lowest Theta value are all located in Gurgaon district as shown in the Map No. 2.9. Unexpectedly, there is very close resemblence in the pattern of Eta and Theta distribution over the region. Jaipur, Agra, Mathura, Bharatpur and Palwal are the largest mandis but their catchment areas have Theta values from all the four quartile.

**2.5.7 Road Density (Du) :**

This shows the road length per unit area. It has been calculated by dividing road length with the area. Road density is one of the most traditional indicators of transport development. Road density has been depicted by taking notified mandi-areas as the unit of study. We notice well marked gradations of the road densities. The average road density of the region is .356 kms. per sq. km. Agra, Punahana, Hodel, Palwal, Tauru, F.P. Jhirka, Pataudi, Rewari, Delhi, Gurgaon, Nuh, Sohna, Faridabad, and Ballabgarh, which have road density values .36, .50, .43, .52, .62, .68, .47, .48, .66, .46, .47, .50 and .70 respectively, fall above average. The mandis which have highest road density are located in the northern part of the region. See Map No. 2.10. Apart from Ballabgarh (which

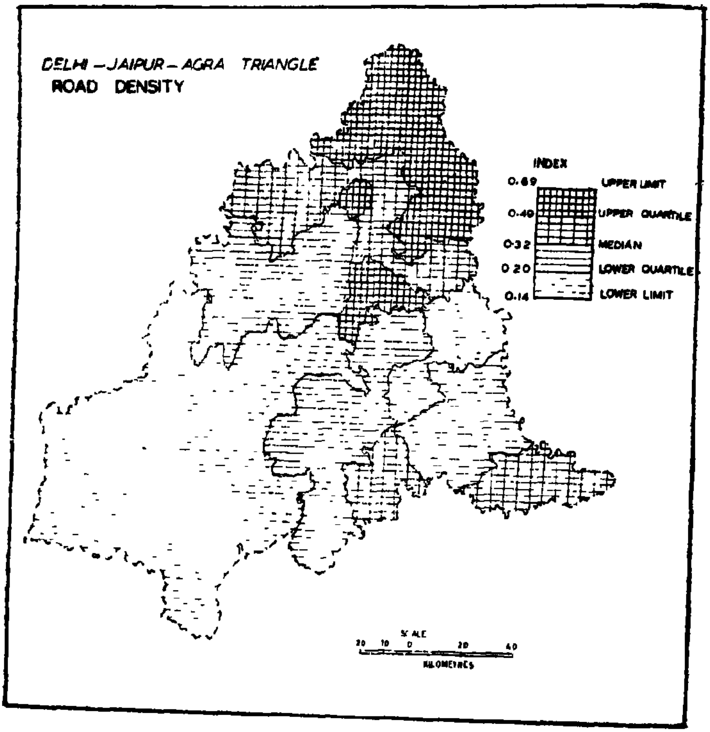

DELHI – JAIPUR – AGRA TRIANGLE
ROAD DENSITY
INDEX
0.69
UPPER LIMIT
0.40
UPPER QUARTILE
0.32
MEDIAN
0.20
LOWER QUARTILE
0.14
LOWER LIMIT
SCALE
KILOMETRES

Fig. : 2.10

has highest road density .70), the mandi-areas to be noted are Ferozepur Jhirka, Gurgaon, Tauru which have road density values .68, .66 and .62 respectively. In the south of this zone lies a second zone which makes a narrow belt from west to east. Further south, the heart of the region is crossed by next zone of lower road density. The remaining south-western part has lowest road density. The road density decreases from north to south and south westwards with some distortions. Road density also increases from south-west to south-east.

**Table No. 2.2**

**Correlation Matrix**

| | *1* | *2* | *3* | *4* | *5* | *6* | *7* |
|---|---|---|---|---|---|---|---|
| 1. Cyclomatic Number ($\mu$) | 1.00 | .6160 | —.2678 | .8234 | —.2343 | —.2129 | .1412 |
| 2. Alpha ($\alpha$) | | 1.00 | —.0309 | .7064 | —.1927 | —.1739 | .0581 |
| 3. Gama ($\gamma$) | | | 1.00 | —.2694 | .0214 | .0484 | .0157 |
| 4. Beta ($\beta$) | | | | 1.00 | —.2598 | —.3190 | .3529 |
| 5. Eta ($\eta$) | | | | | 1.00 | .9557 | —.8014 |
| 6. Theta ($\theta$) | | | | | | 1.00 | —.8621 |
| 7. Road Density | | | | | | | 1.00 |

Road density has a negative and highly significant relationship with eta and theta. It has positive and significant relationship with beta. Cyclomatic number has highly significant positive relationship with alpha and beta only. Theta and eta have shown highly significant and positive relationship. This shows that the variations in the theta index values are quite similar to eta index values in nature. Generally the mandi hinterlands which have low score for theta, they also have less values of eta. The mandi hinterlands which have high score for eta they have high score for theta also.

**2.5.8 Levels of Transport Network Development* :**

The composite index showing the transport network development has the values ranging from 4.05 (minimum) for Kherli to 16.83 (maximum) for Tauru. The most developed and most backward mandi areas (which comes under fourth and first quartile) from the point of view of transport network development are the following (as is revealed from the figures given in Table 2.4 and produced here in summary form) :

| *Mandi Hinterlands with Developed Road Network* | | *Mandi Hinterlands with Backward Road Network* | |
|---|---|---|---|
| | C.I. Value | | C.I. Value |
| Tauru | 16.83 | Kosi | 5.39 |
| Delhi (state) | 15.66 | Kotputli | 5.29 |
| Punahana | 12.41 | Nagar | 5.14 |
| Faridabad | 11.75 | Kaman | 4.98 |
| Mathura | 11.62 | Nadbai | 4.96 |
| Gurgaon | 10.92 | Bandiqui | 4.72 |
| Bharatpur | 10.69 | Mahwa Mandawar | 4.26 |
| Ferozpur Jhirka | 10.13 | Kherli | 4.05 |

All the above mentioned highly developed notified mandi-areas are crossed by national highways except Ferozepur Jhirka, Punahana and Tauru. The attached Map No. 2.11 shows that there are well marked regional variations in the levels of road network development. The north and south-eastern parts of the region have developed transport network. In the north, there are four notified mandi-areas i.e., Pataudi, Sohna, Nuh and Palwal, whose transport development is below average. Bhusawar and Chomu have comparatively high level of road network and surrounded from three sides by lowest level of road network development. It is noted down that most of the

* For methodology see page No. 26.

**Table No. 2.3**

**Indices of Road Network Structure of the Regulated Mandi Hinterlands**

| | *Mandi Hinterlands* | *Cyclomatic number* | *Alpha* | *Gama* | *Beta* | *Eta* | *Theta* | *Road Density* |
|---|---|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* |
| 1. | Tauru | 1 | ·00215 | .6250 | .969 | 2.3871 | 2.3125 | .6216 |
| 2. | F.P. Jhirka | 1 | .00028 | .0238 | 1.00 | 1.7882 | 1.7882 | .6842 |
| 3. | Pataudi | 1 | .00075 | .0370 | .962 | 3.7647 | 3.6226 | .4708 |
| 4. | Rewari | 5 | .00085 | .0190 | 1.036 | 3.3684 | 3.4909 | .4792 |
| 5. | Delhi | 22 | .00387 | .0223 | 1.194 | 4.2170 | 5.0370 | .4941 |
| 6. | Gurgaon | 4 | .00136 | .0269 | 1.038 | 2.1728 | 2.2564 | .6591 |
| 7. | Nuh | 1 | .00101 | .0406 | 0.913 | 3.8095 | 3.4782 | .46 |
| 8. | Sohna | 0 | 0 | .0298 | 0.970 | 3.25 | 3.1515 | .4769 |
| 9. | Faridabad | 4 | .00386 | .0453 | 1.042 | 2.4285 | 2.5319 | .5042 |
| 10. | Ballabgarh | 1 | .00022 | .0206 | .990 | 1.8541 | 1.8350 | .6966 |
| 11. | Jaipur | 2 | .00157 | .0392 | 1.00 | 28.6153 | 28.453 | .1728 |
| 12. | Chomu | 0 | 0 | .1777 | .8 | 2.6406 | 16.9 | .1775 |
| 13. | Kotputli | 0 | 0 | .0866 | .909 | 29.6 | 26.9090 | .1622 |

(Contd. on next page)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 14. | Khairthal | 8 | .00241 | .0264 | 1.089 | 14.44 | 15.2289 | .2468 |
| 15. | Dausa | 0 | 0 | .1111 | .944 | 36.7058 | 34.6666 | .1435 |
| 16. | Bandikui | 0 | 0 | .0866 | .909 | 21.6 | 19.6363 | .1481 |
| 17. | Mahwa Mandawar | 0 | 0 | .0677 | .846 | 17.4545 | 14.7692 | .2031 |
| 18. | Bhusawar | 2 | .00414 | .0996 | 1.045 | 8.6521 | 9.0454 | .3417 |
| 19. | Nadbai | 0 | 0 | .0905 | .905 | 8.4210 | 7.6190 | .325 |
| 20. | Bharatpur | 4 | .00713 | .0639 | 1.086 | 10.73.8 | 11.6571 | .2588 |
| 21. | Agra | 7 | .00358 | .0342 | 1.078 | 7.0144 | 7.5625 | .3603 |
| 22. | Mathura | 4 | .00860 | .0685 | 1.062 | 11.7647 | 12.5 | .263 |
| 23. | Kosikalan | 0 | 0 | .1176 | .941 | 25.00 | 23.5294 | .139 |
| 24. | Deeg | 0 | 0 | .2 | .9 | 23.1111 | 20.8 | .1404 |
| 25. | Kaman | 0 | 0 | .125 | .875 | 13.14 | 11.5 | .234 |
| 26. | Nagar | 0 | 0 | .1111 | .944 | 13.176 | 12.444 | .2946 |
| 27. | Kherli | 0 | 0 | .0391 | .934 | 13.913 | 13.0612 | .2125 |
| 28. | Alwar | 6 | .00210 | .0277 | 1.052 | 15.802 | 16.6233 | .1962 |
| 29. | Punahana | 5 | .00488 | .0523 | 1.071 | 2.4888 | 2.6666 | .5071 |
| 30. | Hodel | 3 | .00149 | .0322 | 1.031 | 3.5820 | 3.6923 | .4333 |
| 31. | Palwal | 0 | 0 | .0249 | .961 | 2.9866 | 2.8717 | .5214 |

**Table No. 2.4**

**Levels of Road Network Development in Delhi-Jaipur-Agra Triangle**

| | | *Cyclomatic number* | *Alpha* | *Gama* | *Beta* | *Theta* | *Road Density* | *Eta* | *Composit Index* |
|---|---|---|---|---|---|---|---|---|---|
| | *1* | *2* | 3 | *4* | *5* | *6* | *7* | *8* | 9 |
| 1. | Tauru | .3876 | 1.3271 | 7.5392 | 1.0358 | 0.2101 | 1.7475 | 4.5877 | 16.8350 |
| 2. | F.P. Jhirka | .3876 | .1728 | .2871 | 1.0689 | .1624 | 1.9235 | 6.1242 | 10.1265 |
| 3. | Pataudi | .3876 | .4629 | .4463 | 1.0283 | .3291 | 1.3236 | 2.9089 | 6.8867 |
| 4. | Rewari | 1.9379 | .5247 | .2292 | 1.1074 | .3171 | 1.3472 | 3.2511 | 8.7146 |
| 5. | Delhi | 8.5271 | 2.3888 | .2689 | 1.2763 | .4576 | 1.3891 | 1.2519 | 15.5597 |
| 6. | Gurgaon | 1.5503 | .8395 | .3253 | 1.1095 | .2050 | 1.8529 | 5.0402 | 10.9227 |
| 7. | Nuh | .3876 | .6234 | .4897 | .9759 | .3160 | 1.2932 | 2.8747 | 6.9605 |
| 8. | Sohna | 0 | 0 | .3595 | 1.0468 | .2863 | .2863 | 1.3407 | 3.3696 |
| 9. | Faridabad | 1.5503 | 2.3827 | .5464 | 1.1138 | .2300 | 1.4174 | 4.5095 | 11.7501 |
| 10. | Ballabgarh | .3876 | .1358 | ·2485 | 1.0582 | .1667 | 1.9583 | 5.9065 | 9.8116 |
| 11. | Jaipur | .7752 | .9691 | .4728 | 1.0689 | 2.5453 | .4858 | .3888 | 6.7059 |
| 12. | Chomu | 0 | 0 | 2.1435 | .8551 | 1.5354 | .4990 | 4.1472 | 9.1802 |
| 13. | Kotputli | 0 | 0 | 1.044 | .9716 | 2.4448 | .4560 | .3699 | 5.2863 |

(Contd. on next page)

| | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
|---|---|---|---|---|---|---|---|---|---|
| 14. | Khairthal | 3.1007 | 1.4876 | .3184 | 1.1581 | 1.3836 | .6938 | .7797 | 8.9225 |
| 15. | Dausa | 0 | 0 | 1.3401 | 1.0091 | 3.1496 | .4034 | .2983 | 6.2005 |
| 16. | Bandikui | 0 | 0 | 1.0446 | .9716 | 1.7840 | .4164 | .5070 | 4.7236 |
| 17. | Mahwa Mandwar | 0 | 0 | .8166 | .9043 | 1.3418 | .5709 | .6274 | 4.2610 |
| 18. | Bhusawar | .7752 | 2.5555 | 1.2014 | 1.1170 | .8218 | .9606 | 1.2657 | 8.6972 |
| 19. | Nadbai | C | 0 | 1.0916 | .9674 | .6922 | .9137 | 1.3005 | 4.9654 |
| 20. | Bharatpur | 1.5503 | 4.4012 | .7708 | 1.1690 | 1.0592 | .7276 | 1.0199 | 10.6898 |
| 21. | Agra | 2.7131 | 2.2098 | .4125 | 1.1523 | .6871 | 1.0129 | 1.5612 | 9.7489 |
| 22. | Mathura | 1.5503 | 5.3086 | .8262 | 1.1352 | 1.1357 | .7394 | .9308 | 11.6262 |
| 23. | Kosi | 0 | 0 | 1.4186 | 1.0058 | 2.1378 | .3908 | .4380 | 5.3910 |
| 24. | Deeg | 0 | 0 | 2.4125 | .9620 | 1.8898 | .3947 | .4738 | 6.1328 |
| 25. | Kaman | 0 | 0 | 1.5078 | .9353 | 1.045 | .6578 | .8334 | 4.9793 |
| 26. | Nagar | 0 | 0 | 1.3401 | 1.0091 | 1.1306 | .8282 | .8311 | 5.1391 |
| 27. | Kherli | 0 | 0 | .4716 | 1.0037 | 1.1866 | .5974 | .7871 | 4.0464 |
| 28. | Alwar | 2.3256 | 1.2963 | .3341 | 1.1245 | 1.5103 | .5595 | .6930 | 7.8353 |
| 29. | Punahana | 1.5504 | 3.0123 | .6308 | 1.1448 | .2423 | 1.4256 | 4.4002 | 12.4064 |
| 30. | Hodel | 1.1628 | .9197 | .3884 | 1.1021 | .3354 | 1.1021 | 3.0573 | 8.1838 |
| 31. | Palwal | 0 | 0 | .3012 | 1.0272 | .2609 | 1.4658 | 3.6668 | 6.7219 |

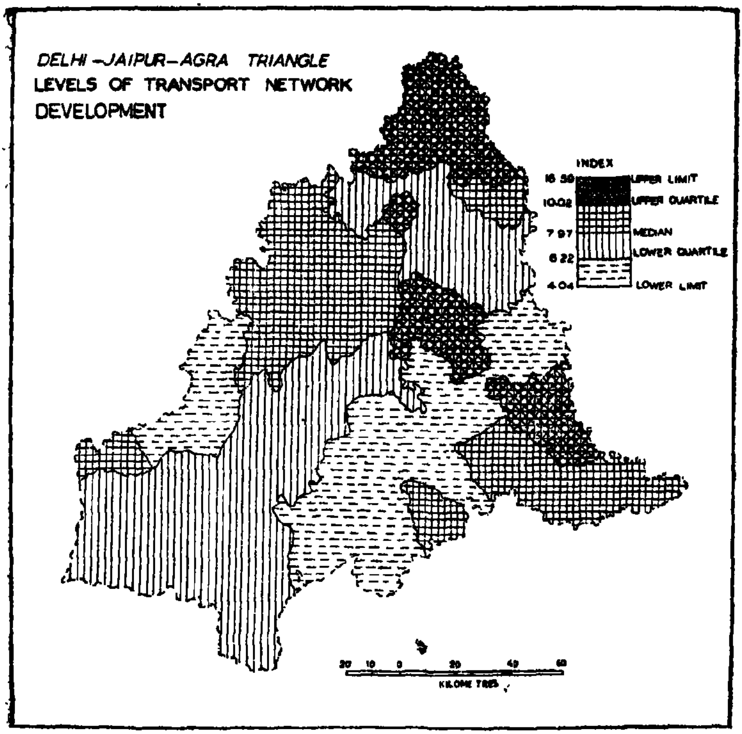

DELHI –JAIPUR–AGRA TRIANGLE
LEVELS OF TRANSPORT NETWORK
DEVELOPMENT
INDEX
16 59
UPPER LIMIT
10.02
UPPER QUARTILE
7 97
MEDIAN
6 22
LOWER QUARTILE
4 04
LOWER LIMIT
20 10 0 20 40 60
KILOMETRES

**Fig. : 2.11**

mandi-areas which have high level of road network, do occupy peripheral positions and most of them are crossed by national highways. On the other hand a big chunk of area in south-east comprising of mandi-areas of Kherli, Mahwa, Deeg, Kaman and Nagar (which have interior location) show the low level of road network development.

## SECTION—III

### 2.6 Accessibility :

After studying the road network structure by taking notified mandi-areas, one gets an idea how effectively the farmers of surrounding villages could bring their produce to the nearby regulated mandis. Here the purpose was to know the transport network development of different mandi-areas. This is not the end of the problem. Crucial problem is how quickly and efficiently the agricultural produce is disposed of from one mandi yard to other commercial centres. Unless the mandi centres are assured of quick disposal, the encouragement for further arrivals is difficult. With the assumption that quick disposal encourages further arrivals, it becomes inevitable to study how various mandi centres are linked with other centres. Hence the accessibility of the regulated mandis have been analysed by taking following indices. These measures are in a position to judge the relative position of individual elements of the transportation network system.

#### 2.6.1 Local Degree (Road) :

The number of routes (edges) joining a vertex or the number of routes crossing or terminating at the vertex is called the local degree. According to Taaffe local degree is the number of routes converging at a node.[8]

Keeping in view the simple nature of the indicator, it is quite easy and quick to find out local degree for the mandis just by counting the number of roads, touching the mandi settlement, local degree of roads has been plotted on Map No.

8. Edward, J. Taaffe, *Geography Transportation*, (N.J., Prentice-Hall Inc., Englewood Cliffs, 1973), p. 119.

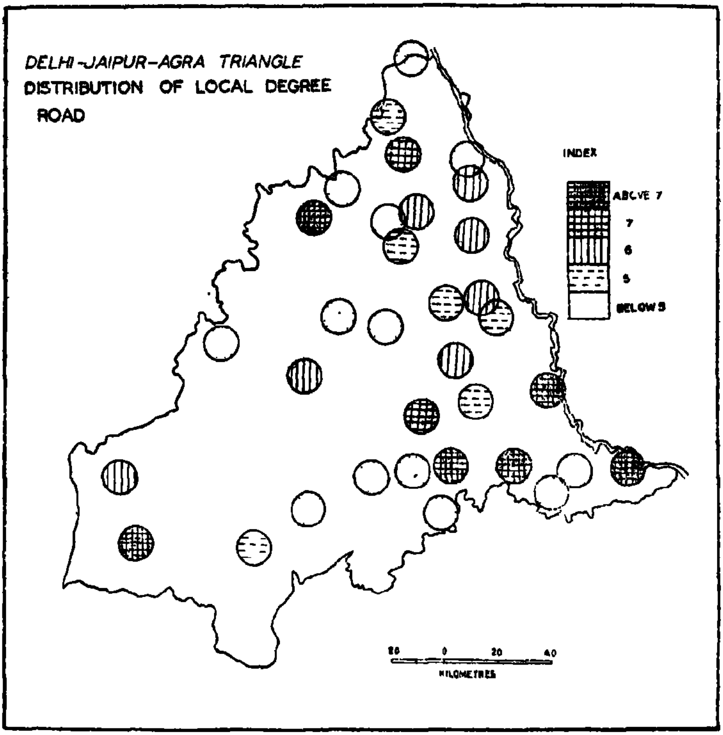

DELHI-JAIPUR-AGRA TRIANGLE
DISTRIBUTION OF LOCAL DEGREE
ROAD
INDEX
ABOVE 7
7
6
5
BELOW 5
20 0 20 40
KILOMETRES

Fig. : 2.12

2.12 with the help of proportionate circles. More than 50 per cent of the region in south-west is characterised with poor mandi network. Widely spaced mandis in this part of the study area have few routes for commercial interactions. Except Jaipur, in extreme south-west, there is no other place which has high local degree (see Map No. 2.12). This map depicts how unevenly the values of this index are distributed in the region. Large number of mandis with moderately high local degree are located from north to south along the western side of Yamuna. The average value for local degree (road) for the region is 5.44. Fifteen mandi nodes have local degree value above average and 19 are below average. The mandi centres which have local degree value below average are Faridabad (4), Pataudi (4), Taura (3), Nuh (5), Punahana (5), F.P. Jhirka (4), Kosi (5), Mahwa (4), Deeg (5), Bandikui (3), Dausa (5), Kotputli (4), Khairthal (4), Kherli (3), Najafgarh (5), Narela (4), and Fatehpur Sikri (4). Mandis which have highest local degree are Agra (9), Bharatpur (9), Rewari (9), Jaipur (8), Mathura (8) and Nadbai (8). All of them occupy marginal position in the region along national highways No. 2, 8 and 11. The eastern belt of the region along the Yamuna river where a well developed mandi network exists, depicts the mandi centres with various levels of local degree. Whatever few mandi-centres are there over desert and hilly track of the region, in western and south-western part, witness few linkages. Alwar district which extends over the central part of the region, its Khairthal mandi has local degree score 4 and because of administrative importance Alwar has local degree value as 6.

**2.6.2 Local Degree (Railways) :**

Local degree (railways) refers to the number of railway tracks crossing or terminating at any place. The mandis which are not linked by railways, are not considered absolutely inaccessible. Rail-links have been considered rather as a relative phenomenon as Ramachandran[9] did. In this region,

9. H. Ramachandran, *Transportation and Urban Attributes—A Case Study of Coimbatore Region*, (Ph.D. Thesis submitted at JNU, New Delhi).

which has 34 mandis, only 23 are on rail-routes. The remaining 11 mandis are also utilising their nearest railway stations. Due to this reason, these 11 mandi centres are given some values in the column of local degree (rail) which can differentiate the distance involved in reaching a railway station. The best way is to take the inverse of the distance involved in reaching the nearest railway station from a mandi centre. Greater the distance, lower will be the accessibility. Among these 11 mandis Tauru, Ferozepur Jhirka and Kotputli have maximum distance from railway stations. Because of this fact they have lowest value (.02) for local degree index. Najafgarh is very near to railway station and it has .8 local degree.

Map No. 2.1 shows that Mathura is the junction where many railway tracks are converging or crossing. Its local degree (rail) is 6. Agra, Rewari, Bharatpur, Jaipur are the other centres which have high local degree (rail), i.e., 5, 5, 4 and 4 respectively. At Bhandikui, in south and Achhnera in south-east three railway tracks make junction. The remaining 16 mandis of the region have only 2 local degree (only one line is crossing the mandi centres). The average local degree (rail) value for Delhi-Jaipur-Agra triangle is 2.07. Seven mandis fall above average and twenty seven have local degree (rail) value below average. Sohna, Tauru, Nuh, Punahana, F.P. Jhirka, Deeg, Kaman, Kotputli, Najafgarh, Bhusawar and Nagar have local degree (rail) value below one and all these centres also fall below average. As triangle formed by national highways, railways also make a triangle of the region, as they run parallel to the National Highways. Hence depriving the interior part of the region from efficient railway facilities. Thus, there is competition between two different modes of surface transportation. Railway lines run parallel to the best highways.

### 2.6.3 Weighted Road Capacity :

The road network system of the region consists of different type of roads. The roads are having different lanes, the lanes are of different width, these have different types of surfaces. Due to these differences, the speed and quantum of the

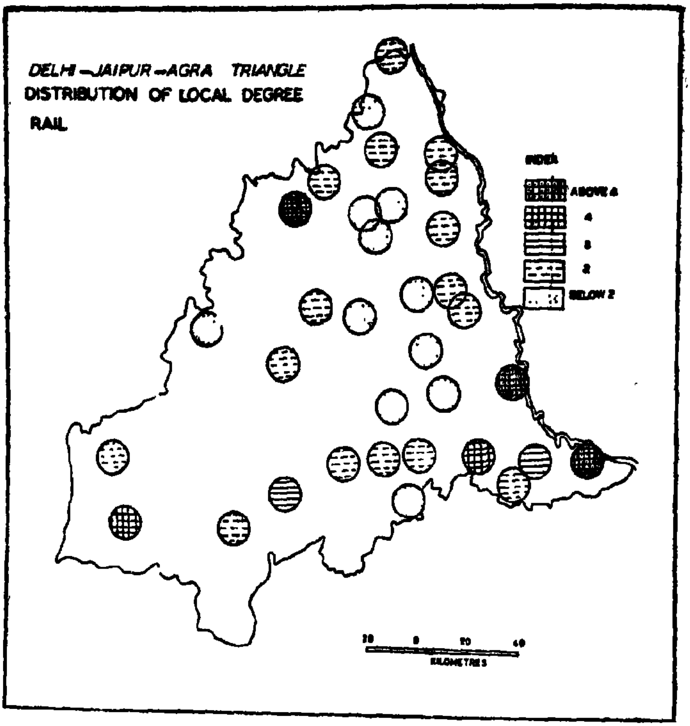

DELHI—JAIPUR—AGRA TRIANGLE
DISTRIBUTION OF LOCAL DEGREE
RAIL
ABOVE 4
4
3
2
BELOW 2
KILOMETRES

Fig. : 2.13

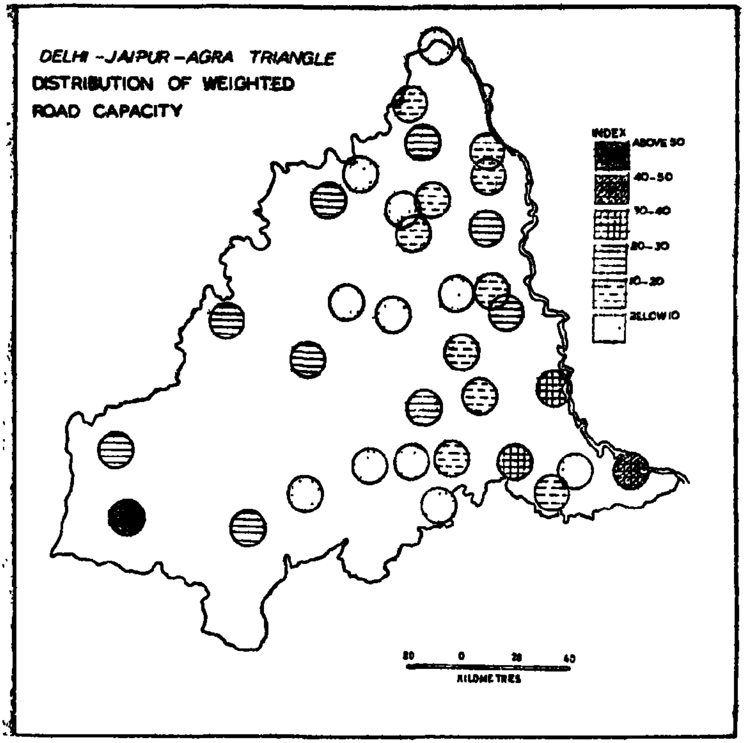

DELHI - JAIPUR - AGRA TRIANGLE
DISTRIBUTION OF WEIGHTED
ROAD CAPACITY
INDEX
ABOVE 50
40-50
30-40
20-30
10-20
BELOW 10
KILOMETRES

**Fig. : 2.14**

commodity movement is different. National Highways, state highways and other roads have different capacities. By ignoring their capacities and putting them merely as a route in local degree is not a justification. Various routes converging at mandi centres should be weighed according to their capacities. Though the scientists and engineers have calculated the road capacities, their calculated capacities lack realism. As guided by NCAER Regional Transport Surveys, if we consider the capacity of district road as one then the respective capacity of the State highway and National highway should be four times and eight times higher than the district road. Thus we have a ratio of 1:4:8 for district roads, State highways and National highways. These figures are multiplied with the local degrees of respective type of roads.

Some interesting conclusions can be drawn by comparing Map No. 2.14. which shows weighted road capacity and Map No. 2.12 which represents local degree for roads. Generally, the mandis which have high local degree for roads also have high score of total road capacity. But most of the mandi centres have changed their relative positions in the sequence. Rewari mandi has highest number of routes (local degree) touching it. After weighting it with the above figures, it has gone down to 6th position. The average value for total road capacity is 18.97. Out of 34 mandis, 16 have total road capacity above average. In the region, Pataudi (4) and Achhnera (4) have the minimum road capacity whereas the minimum local degree was recorded for Bandikui and Tauru. Jaipur (52), Agra (43), Bharatpur (35) and Mathura (34) have emerged most prominent after weighing their routes. The weighed road capacity has made the clear distinctions between various orders of transport nodes. Though Jaipur, Agra and Bharatpur are first, second and third in order after weighting the routes which connect them, large variations in their road capacity values have increased the disparities in the nodality of these large mandis which are important administrative, tourist, religious and commercial centres as well. In the north Gurgaon, Palwal and Rewari have moderately high score of road capacity. Even if road capacity and railway capacity are considered together

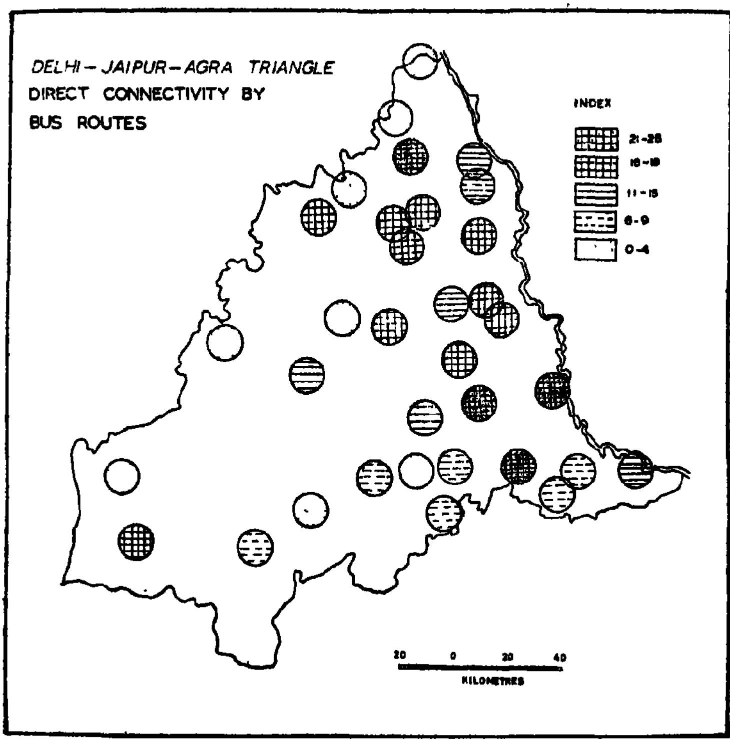

DELHI – JAIPUR – AGRA TRIANGLE
DIRECT CONNECTIVITY BY
BUS ROUTES
INDEX
11 – 15
0 – 4
20 0 20 40
KILOMETRES

**Fig. : 2.15**

most probably these transport nodes may not lose their relative importance. Mainly because the towns which are well served by railways are also well served by roads.

**2.6.4 Direct Connectivity by Bus Routes :**

A n×n matrix was prepared to show the direct linkages of each pair of mandi centres. Value one was assigned to all those cells of the matrix where direct bus link routes were observed. The pair of nodes which don't have direct linkage, zero value was assigned to their respective cells. After making row-wise summation of these values of different cells, direct connectivity figures were obtained for individual mandi centres. Thus index of accessibility suffers from the drawback that if the pair of nodes do not have direct link, it is considered completely disconnected. Whereas in reality it is not so. One *can reach every node from every centre. If more and more* routes are changed it should be considered to have poor accessibility. Anyhow, this aspect has been ignord here. This index tells us about the inter-mandi nodal accessibility within the Triangle itself. The accessibility of border mandis might be different if seen in context of all mandis located in their surroundings but out side the region as well. River Yamuna in the east along the region's boundary serves as a natural barrier. Similarly Aravalli hills also restrict the interaction on either side. The mandi towns which have highest direct bus connectivity are distributed from north to south along the Yamuna river. The mandis located in the heart of the region and in south-west except Jaipur, have poor direct connectivity (See Map No. 2.15). Narela, Najafgarh and Pataudi, are the only mandis located off the main road routes and have very poor direct road linkages. Agra, which is a higher order transport node but shows moderate bus connectivity due to its extreme marginal location. It might be having its interaction with other mandis located outside the region. Hence represents unsatisfactory picture. The average direct connectivity value for the region is 11.94, out of 34 mandis 19 have direct connectivity value above average. Its values range from 25 for Bharatpur to 0 for Narela.

**2.6.5 Tortuosity of Routes :**

This is the ratio between air distance (desired distance) and the actual distance. Higher the zigzagness, lower will be the tortuosity index and vice versa.

The average tortuosity ratio for the region is .817. The *mandi centres which have tortuosity ratio value above average* are Gurgaon (.839), Faridabad (.847), Ballabgarh (.839), Pataudi (.828), Sohna (.923), Tauru (.831), Nuh (.832), Palwal (.831), Mathura (.857), Kosi (.819), Agra (.836), Bharatpur (.833), Dausa (.829), Alwar (.831), Najafgarh (.821), Narela (.818), Fatehpur Sikri (.856), Achhnera (.861) and Nagar (.833). Whereas Rewari (.757), Hodel (.815), Punahana (.784), F.P. Jhirka (.803), Mahwa (.809), Deeg (.803), Kaman (.799), Nadbai (.786), Bandikui (.780), Chomu (.786), Jaipur (.808), Kotputli (.790), Khairthal (.738), Kherli (.773) and Bhusawar (.813) have tortuosity ratio below average. In this region south-western part and mid-western side is characterised by rugged topography which becomes an obstacle in the straight road construction.

**2.6.6 Aggregate Travel Distance (National Highway Accessibility) :**

By aggregate travel distance is meant the total road distance to be covered from a particular node to every other node in the region. For this purpose, a distance matrix was prepared indicating the route distances between 34 mandi centres. Since all the mandi centres are linked with the roads, hence all these distances were measured over the shortest road routes.

The average value for the centrality index for the region is 4229. The places which have peripheral location, have highest value for this variable. The mandi centres which have central most location in the region, have minimum accessibility as indicated by their least value for centrality index. Nagar mandi has minimum value (3048) for this index, is considered as the most inaccessible as compared to all the

other mandis of the triangle. The maximum value is for Jaipur (7076). Since the important assumption of selecting the region was that it makes the triangle of railway routes as well as National highway routes along the region's border. So there must be some index which can reflect the importance of these transport lines. So the mandis located nearer the national-highway will have high aggregate travel distance.

**2.6.7 Accessibility of Mandi Nodes :**

The above discussed indicators (local degree-road, local degree-rail, weighed road capacity, aggregate travel distance and direct connectivity) have been composited* together to arrive at the over all accessibility of the regulated mandis. The accessibility values range from 3.82 minimum (for Bhusawar) to maximum 10.58 for Mathura. Direct connectivity has negative but significant association with aggregate travel distance only. Surprisingly tortuosity ratio and aggregate travel distance have negative association. It is because the travel distance is more for the mandi centres located over the periphery of the region from where national highways have minimum distances. Because of the national highway influence,

**Table No. 2.5**
**Correlation Matrix**

| | | *1* | *2* | *3* | *4* | *5* | *6* |
|---|---|---|---|---|---|---|---|
| 1. | Direct Connectivity | 1.00 | .3971 | —.3289 | .5553 | .1614 | .4654 |
| 2. | Tortuosity Ratio | | 1.00 | —.1550 | .1032 | .0119 | .1528 |
| 3. | Aggregate Travel Distance | | | 1.00 | —.1749 | .4080 | .5063 |
| 4. | Local Degree (Road) | | | | 1.00 | —.5565 | .7754 |
| 5. | Local Degree (Rail) | | | | | 1.00 | .5812 |
| 6. | Total Road Capacity | | | | | | 1.00 |

*See page No. 33.

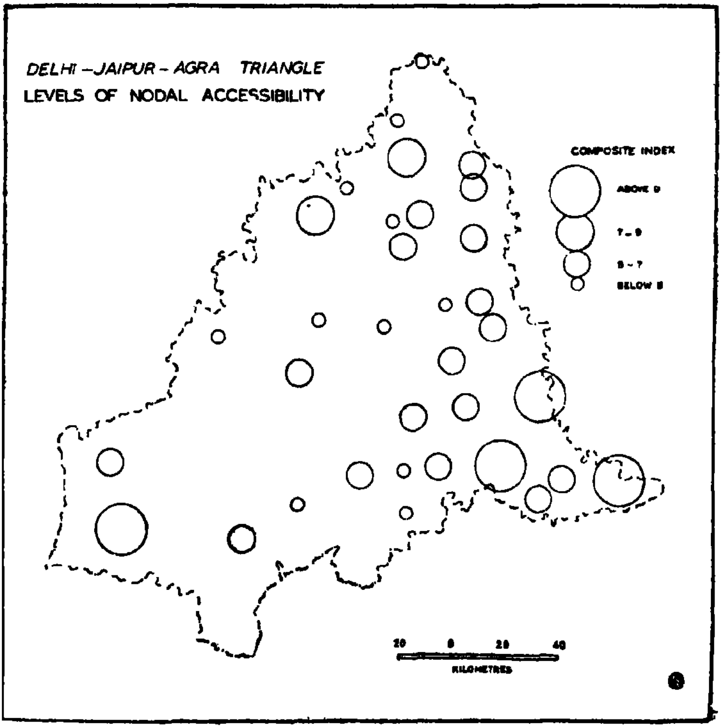

DELHI – JAIPUR – AGRA TRIANGLE
LEVELS OF NODAL ACCESSIBILITY
COMPOSITE INDEX
ABOVE 9
7 – 9
5 – 7
BELOW 5
20 0 20 40
KILOMETRES

**Fig. : 2.16**

the indicator represents positive side. Where as the tortuosity is a negative indicator. In the matrix, local degree road has very high association with total road capacity. Logically, there seems to be the problem of multi-colinearity.

The mandis which have very high and very low accessibility are as follows :

| *Very high accessibility (First Quartile)* | | *Very low accessibility (Fourth Quartile)* | |
|---|---|---|---|
| Mathura | 10.58 | Punahana | 4.69 |
| Bharatpur | 9.85 | Tauru | 4.54 |
| Agra | 9.60 | Kherli | 4.46 |
| Jaipur | 9.44 | Khairthal | 4.45 |
| Rewari | 8.92 | Najafgarh | 4.32 |
| Gurgaon | 7.76 | Pataudi | 4.27 |
| Palwal | 6.98 | Narela | 4.04 |
| Kosi | 6.85 | Kotputli | 3.83 |
| Hodel | 6.83 | Bhusawar | 3.82 |

The accessibility scores for Sohna, Fatehpur Sikri, Achhnera and Chomu are below average. Kaman, Dausa, Nagar and Deeg have their accessibility above average. Alwar and Ballabgarh mandis have moderately high nodal accessibility. The three most accessible mandis are located in the extreme south-eastern corner of the region (Map No. 2.16). The fourth mandi, from accessibility point of view is Jaipur, which is located in extremely opposite side (i.e. south-west). All the highly accessible mandis are found along either of the three national highways. All of them enjoy better railway connectivity as well. In the northern part of the region, Gurgaon and Sohna mandis have comparatively high accessibility. The better accessible mandis occupy peripheral location in the region. Generally, the interior part of the region does not have many highly accessible mandis. The sparse distribution of mandis in the vicinity of Aravalli hills is also characterised by poor accessibility.

**Table No. 2.6**

**Indices of Nodal Accessibility for the Mandi Centres of Delhi-Jaipur-Agra Triangle**

| | *Mandi Centre* | *Direct Connectivity* | *Tortuosity Ratio* | *Aggregate Travel distance* | *Local Degree Road* | *Local Degree Rail* | *Total Road Capacity* |
|---|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | *6* | *7* |
| *1.* | Gurgaon | 22 | .834 | 4,333 | 7 | 2 | 30 |
| 2. | Faridabad | 15 | .847 | 4,313 | 4 | 2 | 18 |
| 3. | Ballabgarh | 14 | .839 | 4,070 | 6 | 2 | 20 |
| 4. | Pataudi | 3 | .828 | 4,269 | 4 | 2 | 4 |
| 5. | Sohna | 18 | .923 | 3,649 | 6 | .03 | 18 |
| 6. | Rewari | 16 | .757 | 4,657 | 9 | 5 | 27 |
| 7. | Tauru | 16 | .831 | 3,628 | 3 | .02 | 9 |
| 8. | Nuh | 16 | .832 | 3,436 | 5 | .03 | 11 |
| 9, | Palwal | 17 | .831 | 3,601 | 6 | 2 | 23 |
| 10. | Hodel | 16 | .815 | 3,318 | 6 | 2 | 20 |
| 11. | Punahana | 15 | .784 | 3,277 | 5 | .05 | 5 |
| 12. | F.P. Jhirka | 16 | .803 | 3,187 | 4 | .02 | 10 |
| 13. | Mathura | 23 | .857 | 3,686 | 8 | 6 | 34 |
| 14. | Kosikalan | 17 | .819 | 3,307 | 5 | 2 | 22 |
| 15. | Agra | 14 | .836 | 5,188 | 9 | 5 | 43 |
| 16. | Mahwa | 9 | .809 | 4,201 | 4 | 2 | 10 |
| 17. | Bharatpur | 25 | .833 | 3,873 | 9 | 4 | 35 |
| 18. | Deeg | 21 | .803 | 3,350 | 5 | .03 | 17 |
| 19. | Kaman | 17 | .799 | 3,296 | 6 | .04 | 18 |
| 20. | Nadbai | 9 | .786 | 3,785 | 8 | 2 | 14 |
| 21. | Bandikui | 3 | .780 | 4,802 | 3 | 3 | 9 |
| 22. | Chomu | 2 | .786 | 7,064 | 6 | 2 | 26 |
| 23. | Dausa | 8 | .829 | 5,484 | 5 | 2 | 25 |

*(Contd. on next page)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 24. Jaipur | 18 | .808 | 7,076 | 8 | 4 | 52 |
| 25. Kotputli | 2 | .798 | 4,936 | 4 | .02 | 21 |
| 26. Alwar | 15 | .831 | 3,721 | 6 | 2 | 21 |
| 27. Khairthal | 2 | .738 | 3,978 | 4 | 2 | 10 |
| 28. Kherli | 4 | .773 | 3,855 | 3 | 2 | 9 |
| 29. Najafgarh | 1 | .821 | 4,991 | 5 | .06 | 20 |
| 30. Narela | 0 | .818 | 5,979 | 4 | 2 | 10 |
| 31. Fatehpur Sikri | 7 | .856 | 4,229 | 4 | 2 | 18 |
| 32. Achhnera | 8 | .861 | 4,207 | 4 | 3 | 4 |
| 33. Bhusawar | 6 | .813 | 4,012 | 4 | .05 | 10 |
| 34. Nagar | 11 | .833 | 3.048 | 7 | .04 | 22 |

**Table No. 2.7**

**Indices of Nodal Accessibility (Scale Free Values) for the Mandi Centres of Delhi-Jaipur-Agra Triangle**

| | *Mandi Centre* | *Direct Connectivity* | *Tortuosity Ratio* | *Aggregate Travel Distance* | *Local Degree Road* | *Local Degree Rail* | *Total Road Capacity* | *Composite Index* |
|---|---|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* |
| 1. | Gurgaon | 1.84 | 1.02 | 0.976 | 1.27 | 1.07 | 1.58 | 7.76 |
| 2. | Faridabad | 1.25 | 1.03 | 0.980 | 0.73 | 1.07 | 0.95 | 6.02 |
| 3. | Ballabgarh | 1.17 | 1.02 | 1.04 | 1.09 | 1.07 | 1.05 | 5.45 |
| 4. | Pataudi | 0.25 | 1.01 | 0.99 | 0.73 | 1.07 | 0.21 | 4.27 |
| 5. | Sohna | 1.51 | 1.13 | 0.85 | 1.09 | 0.01 | 0.95 | 5.55 |
| 6. | Rewari | 1.34 | 0.92 | 0.91 | 1.64 | 2.69 | 1.42 | 8.92 |
| 7. | Tauru | 1.34 | 1.01 | 1.16 | 0.54 | 0.01 | 0.47 | 4.54 |
| 8. | Nuh | 1.34 | 1.02 | 1.23 | 0.91 | 0.01 | 0.58 | 5.09 |
| 9. | Palwal | 1.42 | 1.01 | 1.17 | 1.09 | 1.07 | 1.21 | 6.98 |
| 10. | Hodel | 1.34 | 0.99 | 1.27 | 1.09 | 1.07 | 1.05 | 6.83 |
| 11. | Punahana | 1.25 | 0.96 | 1.29 | 0.91 | 0.02 | 0.53 | 4.94 |
| 12. | F.P. Jhirka | 1.36 | 0.98 | 1.33 | 0.73 | 0.01 | 0.53 | 4.94 |
| 13. | Mathura | 1.92 | 1.04 | 1.15 | 1.46 | 3.23 | 1.79 | 10.58 |
| 14. | Kosikalan | 1.42 | 1.00 | 1.28 | 0.91 | 1.07 | 1.16 | 6.85 |
| 15. | Agra | 1.17 | 1.02 | 0.81 | 1.64 | 2.69 | 2.27 | 9.60 |
| 16. | Mahwa | 0.76 | 0.98 | 1.01 | 0.73 | 1.07 | 0.53 | 5.08 |
| 17. | Bharatpur | 2.11 | 1.02 | 1.09 | 1.64 | 2.15 | 1.84 | 9.85 |
| 18. | Deeg | 1.77 | 0.98 | 1.26 | 0.91 | 0.01 | 0.89 | 5.82 |
| 19. | Kaman | 1.42 | 0.97 | 1.28 | 1.09 | 0.02 | 0.95 | 5.74 |
| 20. | Nadbai | 0.75 | 0.96 | 1.12 | 1.46 | 1.07 | 0.74 | 6.11 |
| 21. | Bandikui | 0.25 | 0.95 | 0.88 | 0.55 | 1.61 | 0.47 | 4.71 |
| 22. | Chomu | 0.16 | 0.96 | 0.58 | 1.09 | 1.07 | 1.37 | 5.26 |
| 23. | Dausa | 0.67 | 1.01 | 0.77 | 0.91 | 1.07 | 1.32 | 5.75 |

(*Contd. on next page*)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 24. | Jaipur | 1.51 | 0.98 | 0.597 | 1.46 | 2.15 | 2.74 | 9.43 |
| 25. | Kotputli | 0.16 | 0.96 | 0.856 | 0.73 | 0.01 | 1.11 | 3.82 |
| 26. | Alwar | 1.25 | 1.01 | 1.136 | 1.09 | 1.07 | 1.11 | 6.68 |
| 27. | Khairthal | 0.16 | 0.90 | 1.06 | 0.73 | 1.07 | 0.53 | 4.45 |
| 28. | Kherli | 0.33 | 0.94 | 1.097 | 0.55 | 1.07 | 0.47 | 4.46 |
| 29. | Najafgarh | 0.08 | 1.00 | 0.847 | 0.91 | 0.43 | 1.05 | 4.32 |
| 30. | Narela | 0.00 | 1.00 | 0.707 | 0.73 | 1.07 | 0.53 | 4.04 |
| 31. | Fatehpur Sikri | 0.58 | 1.04 | 1.00 | 0.73 | 1.07 | 0.95 | 5.37 |
| 32. | Achhnera | 0.67 | 1.05 | 1.00 | 0.73 | 1.61 | 0.21 | 5.27 |
| 33. | Bhusawar | 0.50 | 0.99 | 1.05 | 0.73 | 0.02 | 0.53 | 3.82 |
| 34. | Nagar | 0.92 | 1.02 | 1.38 | 1.28 | 0.02 | 1.16 | 5.78 |

## SECTION—IV

### 2.7 Linkages :

In this section, the patterns of transport connectivity of settlements have been worked out for the region at two levels of areal analysis : first, the interaction of settlements within the mandi hinterland and secondly, the interaction of the village of a particular mandi-area to outside mandis.

By transport connectivity here is meant the linkage of settlements by bus-transport routes. However, no reference has been made either to the frequency of transport or passenger movement by bus. It is presumed here that the bus linkages could give at least the connectivity pattern, though not its intensity. Of the total settlements in the region, 18.03 per cent are along the roads. Settlements along the roads mean all those settlements which are within a distance of one furlong from the roads. The northern part of the region and Agra in south-east have highest proportion of settlements along the roads, because of high road density. Gurgaon, Ballabgarh and Faridabad are the mandis where half of their total settlements are along the roads. The mandi hinterlands which have lowest concentration of settlements along the roads are highly fragmented and make four sub-regions and biggest chunk is located in south-western part of the region. The concentration of settlements along the roads is below 15 per cent in all those mandi hinterlands which lie over the rugged surface of Aravallis in south western part of the region.

### 2.7.1 Settlement Linkages within the Mandi Hinterland :

Here an attempt has been made to investigate into the connectivity amongst the settlements of a mandi hinterland which are along the roads. By connectivity, we mean the linkages of a settlement by bus with other settlements of the mandi hinterland. Thus, if a settlement is linked with a large number of settlements by bus, it is said to have higher connectivity than a settlement which is linked with a few

number of settlements.

(*i*) *High Linkages* :

The settlements of Delhi, Mahwa, Kotputli, Agra, Bhusawar, Jaipur and Palwal mandis have highest degree of linkages where the index values range from 0.0050 to 0.0119. These mandi-areas do not form a contiguous region, but are in fragmented sub-regions in north, south-south-east, south and west. The northern sub-region has the maximum area covering the catchment areas of Palwal, Ballabgarh and Delhi, while the eastern sub-region consists of Agra alone.

(*ii*) *Medium Linkages* :

The mandis of Gurgaon, Nuh, Ferozepur Jhirka, Jaipur and Chomu have moderately high level of connectivity. The index values in these madi-regions range from .0025 to .0048. This region too is fragmented into sub-regions. The northern sub-region consists of mandis of Gurgaon, Nuh, Ferozepur Jhirka and Punahana. The sub-region in south-west consists of Jaipur and Chomu.

(*iii*) *Low Linkages* :

The mandis of low linkages are Nagar, Kosi, Dausa, Nadbai, Mathura and Rewari where the connectivity index values range from .0011 to .0022. The sub-regions of this category are scattered and occupy marginal positions in the region. The south-western sub-region covers the mandis of Dausa and Rewari forms a sub-region in the north-west, Kosi and Mathura form a sub-region in the east.

(*iv*) *Lowest Linkages* :

The mandi-areas which fall under the lowest level of linkages are Khairthal, Bandikui, Kherli, Alwar, Deeg, Kaman, Bharatpur and Fatehpur Sikri, where index values range from .0008 to .0011. Leaving apart, Bandikui, the mandi areas of this level of connectivity are extending from north-west to south-east.

### 2.7.2 Inter-mandi-area Settlement Linkages :

This analysis shows how the villages of one mandi-area are interacting with the settlements of other mandi-areas.

(*i*) *High connectivity and high distance range* :

Mandi-regions with a high degree of connectivity and covering larger range of distance are Dausa, Mahwa, F. Jhirka, Gurgaon, Palwal, Bharatpur, Kotputli, Jaipur, Mathura, Kosi, Bhusawar, Agra, Fatehpur Sikri and Achhnera. These make almost a continuous circular zone, covering maximum area along the national highways. The settlements of Jaipur have maximum interactions with 131 settlements in the region and settlements of Kotputli have minimum connections, only with 21 settlements. The maximum distance of interaction is 284 kms. between the villages of the mandi areas of Jaipur and Gurgaon.

(*ii*) *Low connectivity and low distance range* :

The mandi areas with low connectivity and low distance range are Khairthal, Deeg, Nagar, Kaman, Kherli, Bandikui. They do not form a contiguous region, yet all the sub-zones lie in the middle of the region. The settlements of Deeg have maximum direct connections with 53 setttements. The interaction extends upto a distance of 152 kms. between the villages of Deeg and Delhi.

(*iii*) *Low Connectivity and high distance range* :

The mandi areas of Alwar, Nuh, Ballabgarh, Chomu, Nadbai, Rewari and Delhi fall in this group. These mandi areas form many sub-regions on account of their areal discontiguity. However, a large part of the area with these characteristics is located in the western half of the region. In this group, the settlements of Delhi have maximum direct connections with 141 villages of the region and settlements of Ballabgarh and Faridabad interact only with 35 villages (minimum in the group). The maximum distance of interaction is 300 kms.

## 2.8 Summary and Conclusion :

The northern part of the region has well developed transport-network system which is obvious from thick net of roads. The Aravalli region has poor transport network development and the settlements are sparsely distributed, reflecting the topographical influences. Various patterns of network system, ranging from tree shaped to radial type, are evident from the network study.

In general, the settlements have high road accessibility. Almost 63 per cent of the settlements are within a distance of 2 miles from the roads. But large variations are noticed in different parts of the region. In the northern part of the region (including Delhi State, Gurgaon and Faridabad districts), the percentage of villages which fall within two miles from the roads is as high as 90. Nearly 32 per cent of the settlements of the region are at a distance of 2 to 4 miles away from the roads. Not more than 5 per cent of the settlements of the region are located more than 4 miles away from the roads.

The composite index based on structural indices of transport network shows that there are large regional variations in the levels of road network development for different mandi hinterlands. The analysis based on structural indices shows that the northern and south-eastern parts of the region have most efficient transport network system. It has been noticed that most of the mandi-areas which have high level of road network do occupy peripheral position and most of these are crossed by national highways.

The composite index of accessibility, of mandi-centres, also represents large regional disparities in the nodal accessibility. All the three most accessible mandis are located in the south-eastern part of the region. All the highly accessible mandis are found along either of the three national highways. The mandi centres which have highest road accessibility also enjoy better railway accessibility (barring few exceptions). The sparsely distributed mandis over the Aravalli region are

characterised by poor accessibility. Most of the mandis in the interior part of the region do not have high accessibility. The villages in the mandi hinterlands (traversed by the national highways), have longer distance connections. This can be explained by the fact that national highway tends to link the places of far off distances. The mandis which have interior locations in Delhi-Aga-Jaipur triangle tend to have restricted distance range. All connections, which reflect the high distance range are gravitated towards Agra, Delhi and Jaipur, i.e., indicating their tendency to be closely linked with the national highways and larger urban centres. Generally, the mandi-areas of one national highway do not have interactions with the mandi areas of another national highway.

Pattern of road network shown by Alwar mandi-area is different from other mandi-hinterlands. The mandi area shows radial pattern of roads and the interaction of its settlements extend in all the directions. Its villages have direct-connections with the villages of other mandis, which are crossed by these three national highways.

The mandi-areas which have high connectivity and low distance range are rather few in number and they are located mostly in the middle of the region.

# 3

# Spatial Patterns of Mandi Arrivals (Marketed Surplus)

*When by the improvement and cultivation of land.... the labour of half the society becomes sufficient to provide food for the whole, the other half.... can be employed.... in satisfying the other wants and fancies of mankind.*

—*Adam Smith*

**3.1 Introduction :**

At the very outset, it will be useful to distinguish between marketed and marketable surplus. It is necessary so, because sometimes these two concepts are inter-changeably used. The concept of marketed surplus pertains to that quantity which is put in the market for sale. In contrast to this, the marketable surplus refers to that quantity which is left after satisfying the requirements of producers; wage payments, family consumption and seeds etc. Thus, in a way, marketed surplus is part of marketable surplus. In this chapter, the concern has been basically with the marketed surplus.

The study of the marketed surplus has been organized under the following three heads :

Section-I is devoted to the study of annual arrival patterns and growth of marketed surplus. On the basis of the arrival

size, five major commodities have been selected, namely, wheat, barley, sarson, gram and bajra and their annual arrival patterns are observed [On the basis of the annual arrival data (for 1970 to 1980) obtained from State Agricultural Marketing Boards]. This section consists of two subsections : i.e. (i) regional arrival patterns and (ii) growth of agricultural marketed surplus for different mandis.

Under sub-section (i) regional arrival patterns, the average annual arrival for three years i.e. 1974-1976 were taken for the above mentioned 5 commodities and their spatial description has been given. Under sub-section (ii) growth of agricultural marketed surplus, annual growth rates* for the 5 major commodities were discussed for the decade 1968-1678.

Under section-II, seasonal arrival patterns are analysed on the basis of average monthly arrival data for the year 1975-76. In this section twelve month's arrival data (as percentage to total arrival) for five major crops was grouped into three main periods : (i) post-harvest period, (ii) intermediate period, and (iii) lean period.**

In the III section, mandi types and their linkages with each other are discussed by following McQuitty's (1959)[1] method as used by Garrison et al (1959).[2]

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*Annual growth rate was calculated by the following formula :

$$\frac{\frac{b - P \times 100}{b}}{\text{No. of years}}$$

b stands for the base year. In order to get-base year's data, first three years arrivals were added and its average was taken. P stands for present year. For this latest three years arrivals' average were taken.

**The whole agricultural year has been divided into three parts; (i) the first four harvesting months are called post harvest-period, (ii) the next four months are called intermediate period and (iii) remaining four months, in the last, covers lean period.

1. Louis L. McQuitty, "Elementary Linkage Analysis for Isolating Orthoconal and Oblique Types and Typal Relevancies", *Educational and Psychological Measurement*, Vol. 17, (1957), pp. 207-229.
2. W.L. Garrison, B.J.L. Berry, D.F. Marble, J.D. Nystuen, and R.L. Moryill, *Studies of Highway Development and Geographic Change* (Seattl : University of Washington Press, 1959).

## 3.2 Methodology :

Linkage Analysis Method, as used by Garrison, has been followed. Since the linkage analysis has been used in a few geographical studies, it would be appreciated to start with the difinition of a group or type. According to Clark (1956),[3] a group is a collection of points in which every individual is closer to some member of the collection than to any individual outside of it. This is a hierarchical concept, larger groups containing smaller ones within them. A group may be said to be completely isolated if each of its members is closer to every other member than to any individual outside of the group, from which it follows that every group of two individuals is completely isolated. As referred by McQuitty, a type is a category of persons of such a nature that every one in the category is in some way more like some other person in the category than he is like any one not in the category. In terms of co-efficient of correlations between mandis, every mandi in a type would have a higher correlation with some other mandi in the type than it would with anyone not in the type.

To determine the mandi types of groups as defined above a 34×34 inter correlation matrix of mandi centres was prepared. In other words, Pearson's Product Movement Correlation Coefficient was used to estimate the spatial association of 34 mandis. For 34 mandis, the marketed-surplus data for different agricultural commodities are shown in different rows (Table No. 3.9). All the entries of each column of a particular mandi were correlated with the entries in all the columns. Thus we got an inter-correlation matrix of 34×34 as shown in table No. 3.9. The next step was to underline the highest inter-correlation values in each column. From these underlined values, the highest value was picked up. Two mandis must be sharing this highest value. The points for these two mandis are then plotted as shown in figure No. 3.12, which makes first type of the mandis. Then all those mandis were selected which were more like the two mandis which are shown in type one. This is possible by making note of the rows of

3. Philip J. Clark, "Grouping in Spatial Distribution", *Science*, Vol. 123 (1956), pp. 123-125.

those two mandis of first type in the matrix and selecting underlined entries in these rows. (See Table No. 3.9). Mandis of the columns thus selected are most like the first two in type I. With this step, some mandis are identified which are like 'first cousins'[4] They are shown in figure as type I. In the next step, all those mandis which are most like first cousins were identified in a similar way. For each row of the first cousin, the columns, which are associated with it by an underlined entry are identified. The mandis of these columns are just like 'second cousins.'[5] These mandis may be plotted with type one. Thus the cousins of different orders may be identified. Excluding all the above classified mandis the whole process was repeated to get another types and their cousins of different orders.

## SECTION—I

### 3.3 Annual Arrival Patterns of Marketed Surplus :

#### (i) *Regional Patterns* :

Mandis which are district headquarters or other important administrative centres, do have very big marketed surplus in absolute terms. Only Gurgaon is an exceptional case, which is a district headquarter and important from administrative point of view, has large population but receives comparatively small quantities of agricultural produce. One of the important reason is that there is a better net work of mandis in Haryana; and hence small hinterlands for mandis. Ballabgarth, Faridabad, Palwal, Hodel, Kosi, Mathura and Agra mandis, located on Delhi-Agra national highway (N.H. 2) do receive 72, 79, 66, 52, 44, 53 and 43 per cent wheat as per cent of their total arrivals.* These mandis contribute 43 per cent

4. First cousin represents those mandis which have most similar characteristics as compared to the main type.

5. Second cousin represents those mandis which have relatively less similar characteristics in relation to main type.

*Total arrival is the addition of the total quantity of wheat, barley, sarson, gram and bajra.

of the total region's wheat. The catchment area of these mandis extends along Yamuna river in the east. Adequate irrigation facilities, fertile alluvial soil and suitable climate are major factors which have encouraged wheat cultivation on commercial level (on large scale) which ultimately lead to high marketed surplus of wheat. Among these mandis which lie on eastern boarder of the region, Agra, Mathura and Palwāl are particularly very important wheat receiving centres. The average wheat arrival at Agra mandi was 515 thousand quintals, the biggest wheat mandi in the region and contributes 20.16 per cent of region's total wheat. Agra is the only mandi where arrival for all other four major commodities shows high records of the region's total, contributes 17.44 per cent sarson, 15.97 per cent gram, 19.68 per cent bajra and barley 9.96 per cent. Among the commodities analysed, bajra is the least important in quantity terms as compared to other commodities (around 100 thousand quintals). Agra is also the most important gur mandi with an average arrival of more than 200 thousand quintals. In the whole region there are only five mandis where gur is being sold in large quantities. Three of them are Agra, Mathura and Kosikalan, located in extreme south-east. Jaipur and Alwar are the other two located in south west of the region. Jaipur is the second major wheat receiving mandi in the region (about 16 per cent of the total wheat). Though share of wheat to the total arrivals is 46 per cent for this mandi. Agra and Jaipur which are first and second major wheat mandis contribute 35.6 per cent of the total wheat marketed in the region, do have extremely marginal location in the region, one in south east and other in south west. At Jaipur the percentage of wheat arrivals is 39.40 and at Agra is 43.66. One-fourth mandis contributing to three-fourth wheat in the region are Agra, Jaipur, Mathura, Kosi, Hodel, Palwal, Ballabgarh, Faridabad, Narela, Najafgarh which have wheat as the first major commodity, contribute 72.25 per cent of the total wheat marketed in the region.

Out of 34 mandis analysed on the map, (Fig. No. 3.1) ten have sarson as the first major arrival in the triangle and contribute 58.49 per cent of the total sarson marketed in the region.

**Table No. 3.1**

**Proportion of Individual Crops to the Region's Marketed Surplus**

| *Sl. No.* | *Mandi* | *Wheat* | *Sarson* | *Gram* | *Bajra* | *Barley* |
|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | *6* |
| 1. | Ballabgarh | 1.70 | 0.13 | 0.13 | 0.82 | 0.60 |
| 2. | Faridabad | 1.57 | 0.15 | 0.21 | 069 | 0.16 |
| 3. | F.P. Jhirka | 0.19 | 1.18 | 0.71 | 0.28 | 0.43 |
| 4. | Gurgaon | 0.61 | 0.07 | 0.13 | 0.32 | 0.14 |
| 5. | Hodel | 3.35 | 0.62 | 0.31 | 049 | 4.25 |
| 6. | Nuh | 0.46 | 0.97 | 1.28 | 0.12 | 1.85 |
| 7. | Pataudi | 0 33 | 0.24 | 0.25 | 0.62 | 4.57 |
| 8. | Palwal | 4.81 | 0.74 | 0.21 | 1.37 | 2.91 |
| 9. | Punahana | 0.41 | 0.46 | 0.47 | 0.17 | 0.98 |
| 10. | Sohna | 0.56 | 0.53 | 0.15 | 1.08 | 1.41 |
| 11. | Tauru | 1.08 | 1.13 | 0.71 | 1.04 | 2.55 |
| 12. | Rewari | 2.60 | 7.40 | 4.89 | 4.33 | 13.55 |
| 13. | Kaman | 0.13 | 4.00 | 2.16 | 1.71 | 0.81 |
| 14. | Kosikalan | 3.96 | 2.14 | 0.74 | 0.38 | 5.87 |
| 15. | Mathura | 6.66 | 4.08 | 1.16 | 3.59 | 4.06 |
| 16. | Bharatpur | 1.71 | 11.55 | 1.37 | 1.85 | 1.27 |
| 17. | Chomu | 0.60 | 0.07 | 4.66 | 1.87 | 0.31 |
| 18. | Jaipur | 15.50 | 1.25 | 20.38 | 18.21 | 18.45 |
| 19. | Dausa | 1.19 | 0.43 | 2.28 | 5.46 | 1.43 |
| 20. | Kotputli | 0.23 | 0.37 | 5.73 | 2.23 | 0.93 |
| 21. | Nadbai | 1.07 | 3.26 | 4.02 | 0.88 | 0.60 |
| 22. | Deeg | 0.67 | 4.63 | 2.55 | 1.89 | 1.45 |
| 23. | Khairthal | 2.05 | 6.79 | 3.00 | 4.08 | 2.86 |
| 24. | Alwar | 2.49 | 13.00 | 7.66 | 6.05 | 4.99 |

*(Contd. on next page)*

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 25. Kherli | 1.28 | 10.34 | 6.50 | 3.10 | 8.14 |
| 26. Mahwa | 1.50 | 2.86 | 4.14 | 1.98 | 1.79 |
| 27. Bandikui | 0.97 | 0.74 | 3.01 | 6.78 | 1.79 |
| 28. Agra | 20.16 | 17.44 | 15.97 | 19.68 | 9.96 |
| 29. Achhnera | 0.86 | 0.45 | 0.31 | 0.66 | 0.48 |
| 30. Fatehpur Sikri | 0.42 | 0.88 | 0.33 | 0.22 | 0.41 |
| 31. Nagar | 0.06 | 0.19 | 0.25 | 0.07 | 0.01 |
| 32. Bhusawar | 0.15 | 0.01 | 0.05 | 0.09 | 0.01 |
| 33. Najafgarh | 0.69 | 0.37 | 1.10 | 4.05 | 0.47 |
| 34. Narela | 13.85 | 1.54 | 3.17 | 3.83 | 0.53 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table No. 3.2**

**Proportion of Different Crops to the Individual Mandis**

| *Sl. No.* | *Mandi* | *Wheat* | *Sarson* | *Gram* | *Bajra* | *Barley* |
|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | *6* |
| 1. | Ballabgarh | 72.36 | 3.17 | 2.07 | 7.42 | 14.96 |
| 2. | Faridabad | 79.35 | 4.31 | 4.14 | 7.39 | 4.81 |
| 3. | F.P. Jhirka | 13.06 | 46.17 | 16.79 | 4.27 | 17.71 |
| 4. | Gurgaon | 71.70 | 4.49 | 5.85 | 7.93 | 10.03 |
| 5. | Hodel | 52.14 | 5.36 | 1.84 | 1.64 | 39·02 |
| 6. | Nuh | 17.52 | 20.64 | 18.87 | 1.01 | 41.91 |
| 7. | Pataudi | 9.81 | 3.93 | 2.52 | 3.94 | 79.51 |
| 8. | Palwal | 65.76 | 5.61 | 1.12 | 4.02 | 23.49 |
| 9. | Punahana | 27.93 | 17.54 | 12.47 | 2.54 | 39.52 |
| 10. | Sohna | 28.26 | 15.04 | 2.98 | 11.70 | 42.01 |
| 11. | Tauru | 45.84 | 26.80 | 11.56 | 9.44 | 63.67 |
| 12. | Rewari | 14.71 | 23.60 | 10.73 | 5.29 | 45.49 |
| 13. | Kaman | 3.17 | 55.36 | 20.62 | 9.08 | 11.17 |
| 14. | Kosikalan | 43.86 | 13.37 | 7.02 | 0.90 | 38.69 |
| 15. | Mathura | 53.03 | 18.20 | 3.56 | 6.13 | 19.08 |
| 16. | Bharatpur | 17.35 | 65.65 | 5.37 | 4.03 | 7.59 |
| 17. | Chomu | 19.92 | 1.24 | 59.53 | 13.26 | 6.05 |
| 18. | Jaipur | 39.90 | 1.79 | 20.21 | 10.04 | 18.85 |
| 19. | Dausa | 27.45 | 5.61 | 20.36 | 27.07 | 1.43 |
| 20. | Kotputli | 6.31 | 5.66 | 60.12 | 13.00 | 0.93 |
| 21. | Nadbai | 21.48 | 36.61 | 31.05 | 3.79 | 0.60 |
| 22. | Deeg | 12.16 | 47.07 | 17.83 | 7.34 | 1.45 |
| 23. | Khairthal | 21.42 | 39.69 | 12.08 | 9.14 | 2.86 |
| 24. | Alwar | 14.66 | 42.90 | 17.41 | 7.65 | 4.99 |

(*Contd. on next page*)

| 1 | | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 25. | Kherli | 8.49 | 38.48 | 16.67 | 4.41 | 8.14 |
| 26. | Mahwa | 24.25 | 25.91 | 25.87 | 6.88 | 1.79 |
| 27. | Bandikui | 19.28 | 8.11 | 22.95 | 28.73 | 1.79 |
| 28. | Agra | 43.66 | 21.14 | 13.33 | 9.13 | 9.96 |
| 29. | Achhnera | 52.00 | 15.14 | 7.33 | 8.53 | 0.48 |
| 30. | Fatehpur Sikri | 31.54 | 36.98 | 9.66 | 3.60 | 0.41 |
| 31. | Nagar | 19.94 | 37.84 | 34.36 | 5.18 | 0.01 |
| 32. | Bhusawar | 73.68 | 2.92 | 10.33 | 9.55 | 0.01 |
| 33. | Najafgarh | 79.51 | 2.41 | 4.87 | 10.02 | 0.47 |
| 34. | Narela | 81.16 | 5.04 | 7.17 | 4.81 | 0.53 |
| | TOTAL | 36.37 | 20.35 | 14.01 | 7.79 | 21.47 |

Their individual contribution to the region's total marketed sarson is 13.00 per cent for Alwar, 6.79 for Khairthal, 10.34 for Kherli, 11.55 for Bharatpur, 3.26 for Nadbai, 4.63 for Deeg, 4.00 for Kaman, 2.86 for Mahwa, 0.88 for Fatehpur Sikri and 1.18 per cent for Ferozepur Jhirka. The important thing is that the hinterland of these mandis (Alwar, Khairthal, Kherli, Bharatpur, Nadbai, Deeg, Kaman, Mahwa, Fetehpur Sikri and Ferozepur Jhirka) make a continuous region in the heart of Delhi-Jaipur-Agra-Triangle. If Agra is taken with this region, will account for 75.93 per cent of the total marketed sarson. Among these ten mandis, Alwar has the maximum arrival of sarson (i.e. 185 thousand quintals), but less than Agra where sarson is the second major commodity with a quantity of 249 thousand quintals. The share of sarson at Bharatpur is higher, 65.65 per cent, at Kaman the percentage of sarson to its total marketed surplus is 55.36, for Ferozepur Jhirka it is 46.17, for Deeg it is 47.07.

Though most of the mandis in south, south-west receive gram, but Chomu and Kotputli are the only mandis where gram is the first major agricultural product, as shown by its arrival size. For each of these two mandis, the arrival of gram is around 60 per cent individually. But their contribution to the region's gram arrivals is hardly 10.39 per cent. Again, Jaipur and Agra, which contribute 20.38 and 15.97 per cent respectively, are the major gram contributors in the region.

Mandis where barley is the major commodity are Pataudi, Rewari, Tauru, Sohna, Nuh and Punahana. Except Punahana, all these are located in the close vicinity of Aravalli range in Haryana state and mostly along the Rajasthan border in the north-western part of the region. The most important contributors towards the region's total barley are the Jaipur with 18.45 per cent and Rewari 13.55 per cent. The percentage of barley to the total arrival size at Pataudi, Tauru, Sohna, Nuh and Punahana is 79.51, 63.67, 42.01, 41.91 and 39.52 respectively. But all these five mandis (Pataudi, Tauru, Sohna, Nuh and Punahana) could hardly contribute 11.36 per cent of the total region's barley. Bajra is most important product at

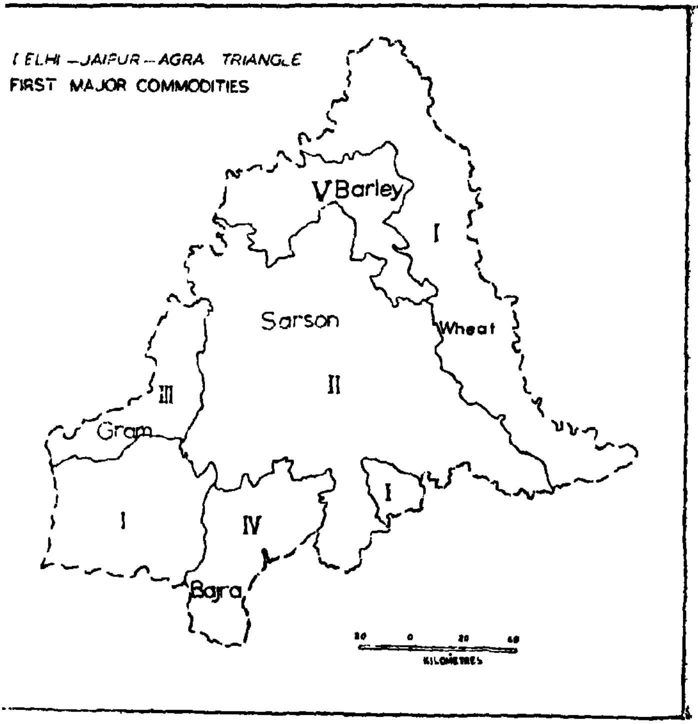

DELHI —JAIPUR—AGRA TRIANGLE
FIRST MAJOR COMMODITIES
V Barley
I
Sarson
Wheat
II
III
Gram
I
IV
I
Bajra
KILOMETRES

Fig. : 3.1

Dausa and Bandikui where its arrival is 27 per cent and 29 per cent respectively. But their total contribution to the region's total arrivals is only 12 per cent. Chomu Kotputli and Sohna are other mandis where the proportion of bajra is relatively high.

There are thirteen mandis which have wheat as the first major arrival in the region. Nine lie on Delhi-Agra national highway along the Yamuna river whose catchment area makes a continuous region. The hinterlands of other three mandis (Jaipur, Bhusawar and Gurgaon) are also connected by national highway. These are scattered and occupy peripheral positions. The sarson dominated mandis catchment area extends almost in the heart of the region and occupies maximum space. There are only six mandis where barley is the first major arrival and lie in the north western part of the region. All these are Haryana mandis and located along the Rajasthan border, mostly along the Aravalli range. There are two patches of gram and bajra dominated mandis in the south-western part of the region, each having two mandis.

## 3.4 Growth of Marketed Surplus :

### (*i*) *Wheat-Marketed Surplus* :

#### (*a*) *Negative Growth* (*below zero*) :

In all, eight mandis of the region (Dausa, Kosi, Kaman, Nagar, Deeg, Bharatpur, Fatehpur Sikri and Achhnera) recorded negative annual growth of wheat in the grain market. Except Dausa (Which is in south-west), all other seven wheat collection points are in the south-east and occupy a continuous area. The negative growth rate for wheat varies from-2 per cent for Bharatpur (minimum) to-10 per cent for Kaman (maximum). It is interesting to note that Bharatpur, Kosi and Kaman mandis of negative growth rate of wheat marketed surplus record very high positive annual growth rate of barley (See Map No. 3.2).

#### (*b*) *Low Growth* (*0—10 per cent*) :

Half of the ragion's mandis have low annual growth rate

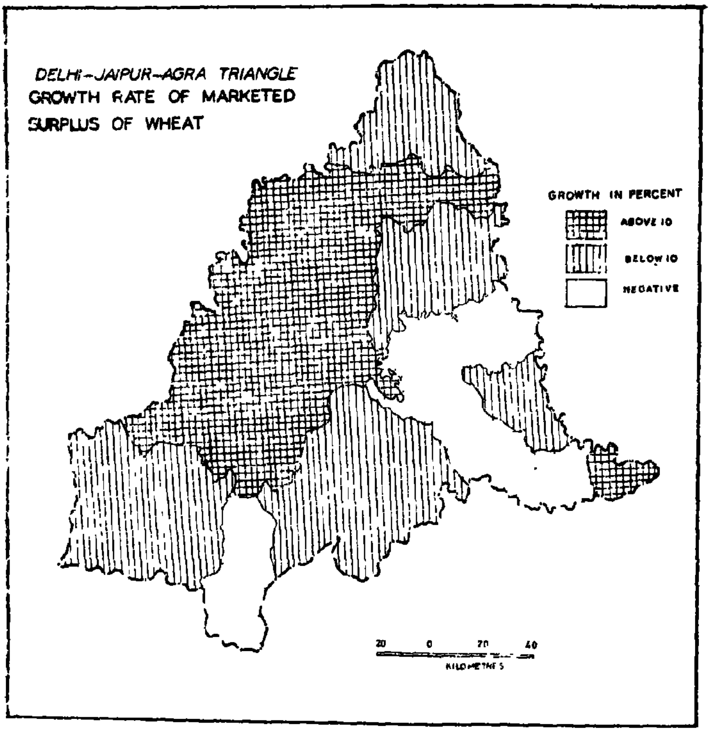

DELHI-JAIPUR-AGRA TRIANGLE
GROWTH RATE OF MARKETED
SURPLUS OF WHEAT
GROWTH IN PERCENT
ABOVE 10
BELOW 10
NEGATIVE

Fig. : 3.2

of wheat, i.e. from 0 to 10 per cent. Narela in the extreme north, Mathura in the south-east and Jaipur in south-west have 6 per cent annual growth rate. Najafgarh, Gurgaon and Fridabad in the north and Palwal and Hodel in the north-east have 8 per cent growth rate for wheat. Chomu and Nadbai have experienced 5 per cent growth rate. In mid-south; Bandikui has 10 per cent growth rate, Mahwa-Mandawar 0.3 per cent, Kherli 3 per cent and Bhusawar 4 per cent.

(*c*) *High Growth* (*above 10 per cent*) :

Except Agra, all the mandis which have high annual growth rate of wheat are located in north-south direction in the mid-west region. Through Sohna and Ballabgarh this belt touches the Yamuna river. Among these mandis. Alwar and Agra have exceptionally very high growth rate for wheat, i.e. 230 per cent and 304 per cent respectively. Kotputli has 50 per cent growth rate, Kairthal 13 per cent, Rewari 13 per cent, Pataudi 14 per cent, Tauru 14 per cent, Sohna and Ballabgarh 14 per cent each.

(*ii*) *Barley Marketed Surplus* :

(*a*) *Negative Growth* (*below zero*) :

Gurgaon in north, Kotputli, Chomu, Jaipur and Dausa in South-west have shown negative annual growth rate for barley. (Fig. 3.3). The south-western mandis are located in a continuous area. The growth rate ranges from-1 for Dausa (minimum) to-21 for Kotputli (maximum). The south western part of negative growth rate is mostly semi-desert area along the Aravalli range.

(*b*) *Low Growth* (*0-10 per cent*) :

Twenty mandis have low annual growth rate of barley. Seventeen mandis out of twenty are located in the heart of the region which is a continuous area of mandi hinterlands. These mandis are Rewari, Pataudi, Tauru, Sohna, Hodel, Punahana,

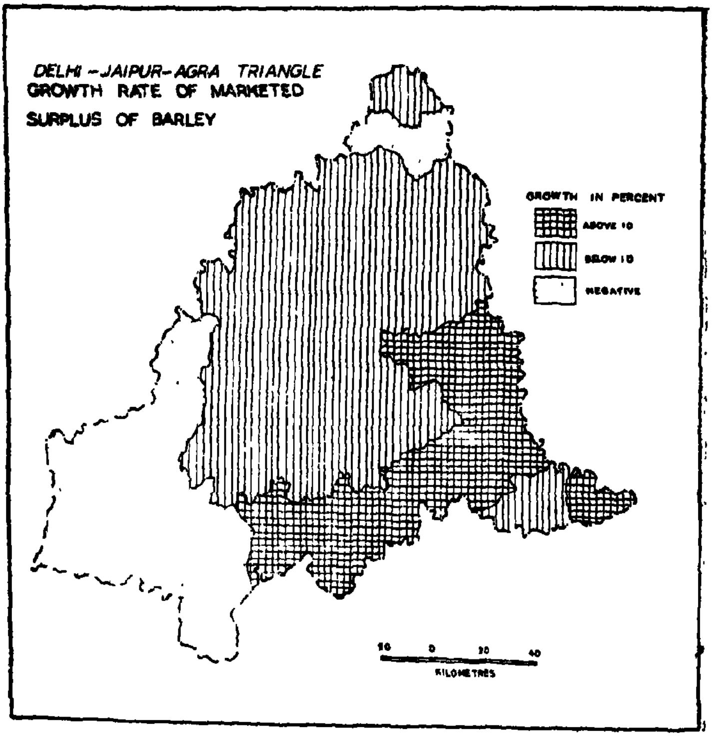

DELHI – JAIPUR – AGRA TRIANGLE
GROWTH RATE OF MARKETED
SURPLUS OF BARLEY
GROWTH IN PERCENT
ABOVE 10
BELOW 10
NEGATIVE
10 0 20 40
KILOMETRES

Fig. : 3.3

F.P. Jhirka and Khairthal, which have 9 per cent growth rate, Gurgaon, Faridabad, Ballabgarh, Deeg and Nagar have 8 per cent growth rate, Kherli 7 per cent, Alwar 6 per cent and Palwal have 1 per cent annual growth of barley. Two mandis in south-east (Achhnera and F. Sikri) have only 1 per cent growth, Narela in extremely north has 8 per cent annual growth of barley.

(*c*) *High Growth (above 10 per cent)* :

All the mandis which have very high growth rate for barley are located in the south eastern part of the region (Fig. 3.3) over a continuous area. These are Agra (113 per cent), Mathura (21 per cent), Kosi (31 per cent), Kaman (33 per cent), Nadbai (21 per cent), Bhusawar (14 per cent), Mahwa Mandawar (14 per cent) and Bandikui (13 per cent).

(*iii*) *Sarson Marketed Surplus* :

(*a*) *Negative Growth (below zero)* :

Almost one-third of the region's total mandis have shown negative annual growth rate for sarson. Surprisingly, all of them are on the national highways and have peripheral Locations. Kosi, Hodel, Palwal, Ballabgarh, Faridabad, Gurgaon and Najafgarh are the mandis which occupy a continuous belt from north to south, almost along the Yamuna river. Kotputli, Chomu and Dausa (in south-west) have-24, -24 and-11 per cent annual growth rate respectively, which is highest among all the mandis which have shown negative growth rate. Bharatpur in the south-east records-4 per cent rate of growth ian the rrival of sarson (Fig. No. 3.4).

(*b*) *Low Growth (below 10 per cent)* :

Mostly the mandis which have low growth rate for sarson, are located in mid-west and central part of the region. These are Rewari (2 per cent), Pataudi (2 per cent), Tauru (2 per cent), Sohna (2 per cent), Nuh (2 per cent), Khairthal (7 per

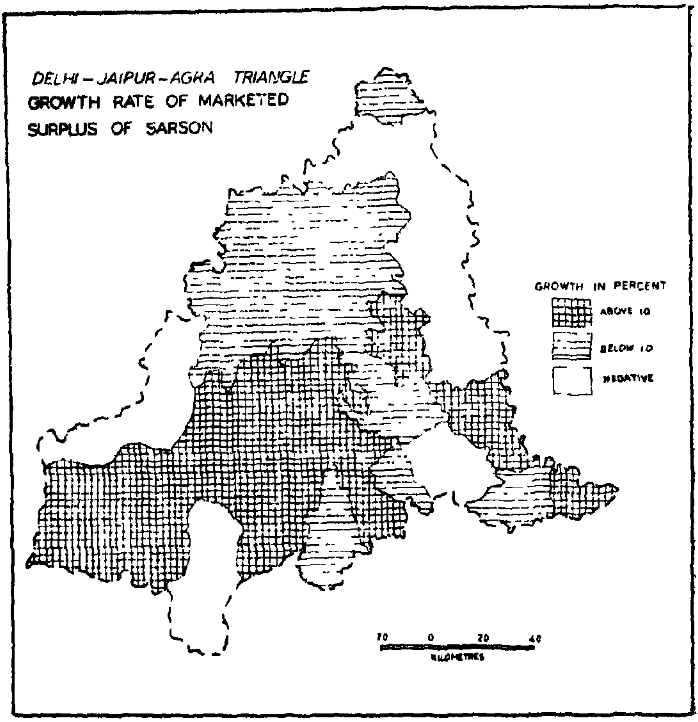

DELHI – JAIPUR – AGRA TRIANGLE
GROWTH RATE OF MARKETED
SURPLUS OF SARSON
GROWTH IN PERCENT
ABOVE 10
BELOW 10
NEGATIVE
20 0 20 40
KILOMETRES

Fig. : 3.4

cent), F.P. Jhirka (7 per cent) and further southwards Nagar (5 per cent), Deeg (5 per cent) and Nadbai (9 per cent). This belt crosses the whole region from north-west to south-east. Mahwa Mandawar (5 per cent) in south and Narela (10 per cent) in North, Achhnera and Fatehpur Sikri (6 per cent) in south-east are the other mandis of low positive growth (Fig. 3.4).

(*c*) *High Growth* (*above 10 per cent*) :

All the mandis which recorded maximum growth rate for sarson are located west to east in the southern half of the region. These are Jaipur (which has 32 per cent annual growth rate), Alwar (92 per cent), Bandikui (11 per cent), Kherli (13 per cent), Bhusawar (11 per cent), Punahana (100 per cent), Kaman (21 per cent), Mathura (25 per cent) and Agra (161 per cent).

(*iv*) *Gram Marketed Surplus* :

(*A*) *Negative Growth* (*below zero*) :

More than half of the region's mandis record negative annual growth rate for gram arrival. There are seventeen mandis covering a continuous area in between Agra (in south-east) and Narela (in extremely north, along the western side of Yamuna (see Fig. 3.5). Thus it is a longitudinal belt extending from north to South in the eastern part of the region. Kotputli and Dausa, which have isolated location, their growth rate is-19 and-7 respectively. Among these 19 mandis the minimum growth rate is for Bharatpur (i.e. -2 per cent) and the maximum is (-19 per cent) for Kotputli. The mandis which have shown negative growth rate for sarson, also record negative growth rate of gram marketed surplus. It is important to note that the area covered by the mandis of negative growth of sarson and gram (area along Yamuna river) has best irrigation facilities and most fertile land.

(*b*) *Low Growth* (*0-10 per cent*) :

A continuous area in central and south-western part of

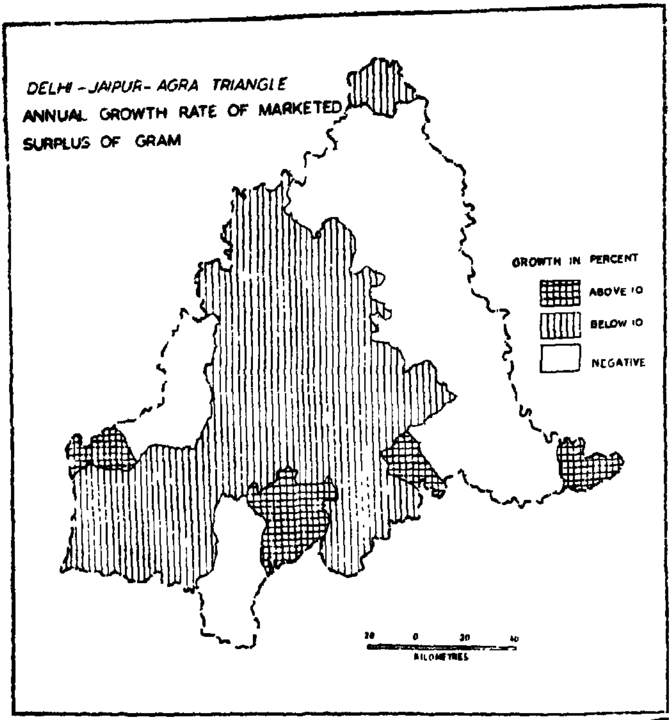

DELHI - JAIPUR - AGRA TRIANGLE
ANNUAL GROWTH RATE OF MARKETED
SURPLUS OF GRAM
GROWTH IN PERCENT
ABOVE 10
BELOW 10
NEGATIVE
0
20
40

Fig. : 3.5

the region is characterised by low growth rate of gram. These are Jaipur (1 per cent), Alwar (10 per cent), Khairthal (9 per cent), Rewari (9 per cent), F.P. Jhirka (9 per cent), Nagar, Deeg, Kherli, Mahwa Mandawar and Bhusawar (2 per cent growth rate each), Narela, in the north, has 4 per cent growth rate.

(*c*) *High Growth (above 10 per cent)* :

Only 4 isolated mandis in the bottom of the region have very high annual growth rate for gram. These are Chomu (208 per cent growth rate), Bandikui (11 per cent), Nadbai (11 per cent) and Agra (140 per cent).

(*v*) *Bajra Marketed Surplus* :

(*a*) *Negative Growth (below zero)* :

The mandis which have negative annual growth for bajra are Najafgarh (-3 per cent), Gurgaon (-3 per cent), Faridabad (-3 per cent), Deeg (-4 per cent), Mahwa Mandawar (-5 per cent), Dausa (-14 per cent), Chomu (-9 per cent) and Khairthal (-8 per cent). These mandis do not occupy continuous are like other commodities. Contrary to it they are scattered over different parts of the region.

(*b*) *Low Growth (0-10 per cent)* :

The mandis which come under low annual growth rate category are 22 in number. These are extending horizontally in southern region and south-westward in the north-east. Any how, the mandi hinterlands of these mandis have territorial linkages with each other. Of these mandis Achhnera, Fatehpur Sikri, Nadbai, Bhusawar, Nagar, F.P. Jhirka, Kotputli, Punahana, Kosi, Hodel, Palwal and Ballabgarh have zero growth rate for bajra.

(*c*) *High Growth (above 10 per cent)* :

The mandis which have highest growth rate for bajra are Narela (20 per cent) in the extreme north, Jaipur (60 per cent)

in the southwest, Agra (869 per cent), Mathura (31 per cent) and Kaman (29 per cent) in south east (Fig. 3.6).

## SECTION—II

### 3.5 Seasonal Arrival Pattern :

(i) *Wheat* : There are well marked seasonal trends in the arrival of various agricultural produce brought in the mandi yards. The agricultural products which are marketed at different mandis, their arrival is not evenly distributed over all the year round. However, Agra and Jaipur regulated mandis (the largest ones) of the region receive only 15 per cent of the total marketed wheat during the busiest months of April/May as shown in Table 3.4. Neither of these two mandis receives more than 46 per cent of wheat during post harvest period. Here in these two most important mandis the seasonal picture could not emerge so prominently because being the centres of national importance, they receive the secondary arrivals* from outside the region even in the off season. Except Achhnera, Fatehpur Sikri and Punahana, all other mandis record more than 50 per cent of the wheat in the post harvest period.

(ii) *Gram* : The region received maximum amount of gram (20 per cent) in the month of May only. April is the second important month for its arrival. 60 per cent of the annual arrival of gram is received within the four busiest months of post-harvest period. Agra receives least quantity in the first busiest month. Leaving apart Gurgaon, Punahana, Bandikui and Agra, all other mandis receive more than 50 per cent of the gram during the post harvest months. Kosi, Najafgarh and Narela mandis which receive as large as three-fourth of the total products only during the post-harvest season.

(iii) *Barley* : The region receives 14 per cent of barley in the first busiest month (May). 50 per cent of the total

*The term secondary arrival has been used for that quantity of marketed surplus which comes from outside the mandi hinterland and not directly from the farmers.

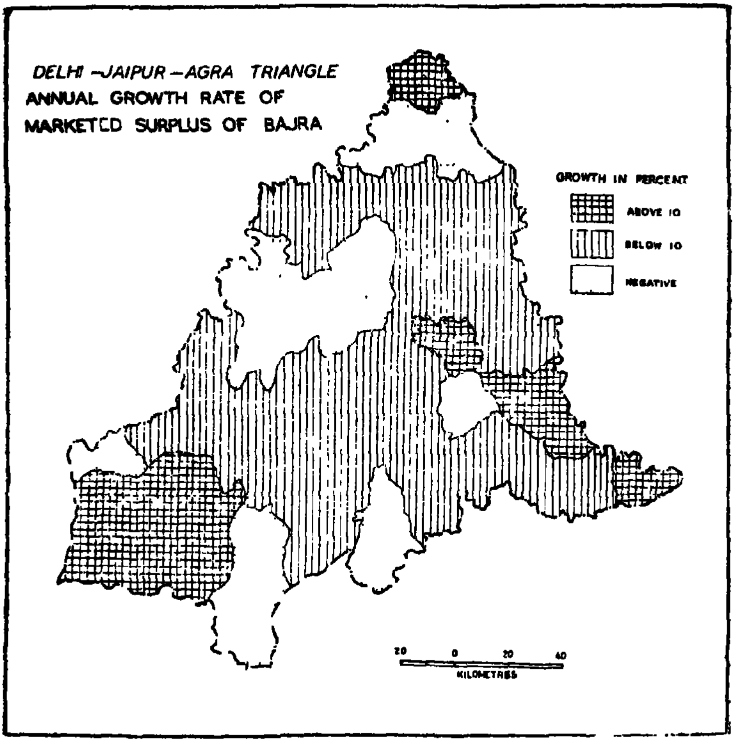

DELHI –JAIPUR – AGRA TRIANGLE
ANNUAL GROWTH RATE OF
MARKETED SURPLUS OF BAJRA
GROWTH IN PERCENT
ABOVE 10
BELOW 10
NEGATIVE
20 0 20 40
KILOMETRES

Fig. : 3.6

annual arrival of the region's barley comes in four months (post-harvest season), 22 per cent in lean period and 27 per cent in intermediate period. The first two busiest months could receive only 25 per cent of the total annual barley of this area. None of the mandis recorded more than 36 per cent of the total barley in any of the busiest months. Again Jaipur, Agra and Mathura which are the largest mandis, could not receive more than 17 per cent of the total barley in any of the busiest months of the year. It is because the mandis receive the secondary arrivals throughout the year. The maximum arrival of barley (74.81 per cent) is recorded for Sohna mandi in the post harvest period.

**Table No. 3.3**

**Seasonal variations in the Arrival of Major Crops in the Region**

| | | *Post harvest Period* | *Intermediate Period* | *Lean Period* |
|---|---|---|---|---|
| | | *1* | *2* | *3* |
| 1. | Wheat | 58.47 | 22.13 | 19.40 |
| 2. | Sarson | 57.00 | 27.00 | 16.00 |
| 3. | Barley | 50.00 | 27.00 | 22.00 |
| 4. | Bajra | 77.27 | 9.73 | 13.00 |
| 5. | Gram | 60.00 | 27.00 | 13.00 |

(*iv*) *Sarson* : Nearly half of the total annual arrival of sarson is received during the first three busiest months of the region. 57 per cent is recorded during the post-harvest season, 16 per cent during lean period and 27 per cent during middle period. The most busiest month of the region is April which receives around 23 per cent of the total sarson of the annual arrivals. Its annual arrival ranges from 11 per cent to 51 per cent in the first busiest month in different mandis of the region. Sohna, Palwal and Tauru are the mandis which receive more than 70 per cent of sarson during post harvest season.

(*v*) *Bajra* : Bajra which is on of the important grain products of Rajasthan, shows lowest arrival in the first busiest month in Jaipur mandi. In case of bajra, we note relatively less disparities in arrival trends over different mandis. There is no mandi in the region which does not receive more than 56 per cent of total marketed bajra during the post harvest season. Of the total bajra of the region, 77.27 per cent is received during post harvest season, 10 per cent during intermediate and 13 per cent during lean period. Nuh, Gurgaon, Kaman and Fatehpur Sikri are the centres which collect more than 90 per cent of bajra during the post harvest season. Khairthal and Sohna are the only mandis of the region which recorded less than 60 per cent bajra during the post harvest season.

**3.6 Mandi-wise Analysis :**

At Agra mandi, the first most busy month receives wheat, gram, barley, sarson, peas and bajra to the extent of 15 per cent, 17 per cent, 16 per cent, 11 per cent, 19 per cent and 33 per cent, respectively. Agra, which is ranked as largest mandi gives very interesting picture in the sense that the proportion of arrival for some of the commoditie in the busiest months is disappointing, whereas for some of the commodities it records large proportion of total annual arrivals within a few busiest months. The most important explanation is that being a large regional centre, it receives huge secondary arrivals from different areas outside the mandi hinterlands. Secondly, the secondary arrivals are received throughout the year.

In case of bajra, Agra mandi records 79 per cent of the total annual arrivals within four months from November to February. Most probably, it is because of its low secondary arrivals. Most of the bajra comes from mandi hinterland itself and farmers sell out their surplus soon after its harvesting period.

*Mandis of Aravalli Foothills* (Gurgaon; Sohna, Nuh F.P. Jhirka, Khairthal, Alwar and Jaipur) : In Nuh and Ferozepur Jhirka mandis, which are located along the eastern foothills of

Aravalli, sarson, gram and barley are the most important commodities brought in the mandi yards from the point of view of quantity. The two mandis are located in the heart of the Mewat region (a distinct socio-cultural region). Nature of the arrivals reflects not only the seasonal and annual trends but also speaks of the nature of its surroundings. The domination of gram, sarson and barley is nothing but a mere reflection of the lack of irrigation and other facilities coupled with unsuitability for modern variety of wheat and commercial crops. The western side of the mandi hinterland along the eastern foothills of Aravalli is absolutely backward from agricultural point of view and is agriculture largely depends on rain. The area is characterised by unfertile soil with barren lands here and there. The abrupt flooding of agricultural products in the mandis, just after the harvesting season, reflects the incapability of the farmers to hold their output. Near about 87 per cent of wheat is brought to Nuh mandi within post harvest season (i.e. April, May, June and July) by the farmers of mandi catchment area. Ferozepur Jhirka receives nearly 72 per cent of the total annual wheat in May, June and July only. Both mandis receive about same quantity of sarson annually. Its major arrival spreads over many months in Ferozepur Jhirka, whereas in case of Nuh, 67 per cent of the commodity comes within three months.

Around 48 per cent of the total annual arrival of wheat is received during the three most busy months i.e., April, May and June. May alone records 21 per cent of total annual arrival. The first two busiest months receive 36 per cent of the total annual arrivals. At Gurgaon mandi, arrival of wheat in comparison to other commodities is high and 53 per cent of it comes in first three busiest months. At Sohna, barley is most important commodity and farmers of the region do not have capacity to retain their produce, hence 75 per cent of the total annual barley is sold out within four months of its harvest. At Punahana, the arrival of wheat is relatively more (around 58 per cent) during the intermediate season. About 84 percent of barley and 98 per cent of peas appear within five most busy months.

More than three-fourth of total annual bajra appears in November, December and January in both the Mewat mandis. Around 50 per cent of the total annual barley is received within three months. The whole triangle received 59 per cent of the annual bajra during these 90 days of winter. The highest arrival of bajra is in December (21 per cent) in the region. The harvesting period of barley starts a bit early hence arrives some days earlier in the market as compared to wheat. More than 85 per cent of total gur comes to Nuh mandi in November and December.

Alwar, Khairthal and Kherli are the only mandis in Alwar district and all of them possess large hinterlands to supply the agricultural products. It is because of the large hilly, barren and infertile land in this district of Rajasthan particularly along the Aravalli, which can not spare much agricultural produce for marketing purpose, hence emerged few mandis. The average annual arrival of sarson, gram and wheat ranges between one to two lakh quintals at Alwar and Kherli. At Khairthal mandi, also the arrival of sarson makes an annual record of more than one lakh quintals. At Alwar half of the total annual sarson is received in the month of March, April and May. March which is the busiest month of Alwar mandi for sarson, receives quarter of the total annual arrivals. April May, June and July receive around 76 per cent of the wheat. Gram and sarson reflects the same seasonal pattern over here. In the first busiest month, both of them receive 25 per cent of their total annual and 52 per cent comes in first three busiest months (as shown in table No. 3.4 and 3.2). Over the winter season near about three fourth of the bajra is brought to the Alwar yard for the sale. Khairthal mandi receives near about 60 per cent of the total annual sarson in March and April only. April, May and June contribute near about 73 per cent of the total wheat. Bajra growers can't afford to hold it with them for a long time. Almost 90 per cent of it is being disposed of between 3 to 4 months through the mandi centre.

Within 90 days (April, May, June, the busiest months), Kherli receives 63 per cent of sarson, 59 per cent of gram, 65 per cent of wheat and more than 85 per cent of arhar.

Kaman mandi is located at Haryana, Uttar Pradesh and Rajasthan border, hence restricted flow of agricultural commodities from far north and east. But large price differentials at many times have encouraged illegal movement of certain commodities. For example there is always scarcity of gur in most of the Rajasthan mandis and that of gram in Haryana and U.P. mandis. Whereever there is control over inter-state movement of some of these commodities, it leads to price differences in the two neighbouring states. It has relatively large arrival of sarson. April is the busiest month of the mandi, obtains about 32 per cent of total annual sarson during this month. It receives 73 per cent of gram and barley in five busiest months. Since both the crops are harvested at the same time the farmers bring them to the market in the same combination. For both the commodities May is the busiest month.

Bajra which is one of the major commodities and records around 70 per cent of arrival over October, November and December at Bandikui, a mandi located in the southern part of the region over railway junction. Here, for gram, April is the most busy month and for wheat May is the dominant one. Arrival of barley is spread almost over all the months. For no month its arrival exceeds 13 per cent. Apart from Agra, Kosikalan and Mathura are large mandis and Achhnera and Fatehpur Sikri are two smaller mandis of Uttar Pradesh located in this study area. Wheat, gur and barley are the dominant commodities of the two large mandis. In case of Mathura, we have large secondary arrivals from different outside areas. As mentioned earlier the secondary arrivals continued in lean period as well. In case of Kosi seasonality of various crops is well marked. Farmers do not prefer to hold gur for a longer period because it may be spoiled in the rainy season. Keeping this in view and economic incapability of the farmers, 84 and 68 per cent arrival of gur comes in Mathura and Kosi respectively within December, January, February and March.

At Kosikalan, 60 per cent of the wheat comes within two busiest months and rest 40 per cent of the arrivals are spread over all other monthes. In case of Mathura, 67 per cent of

**Table No. 3.4**

**Seasonal Variations in Marketed Surplus of Wheat**

| *Sl. No.* | *Name of Mandi* | *Past harvest Period* | *Intermediate Period* | *Lean Period* |
|---|---|---|---|---|
| | *1* | *2* | *3* | *4* |
| 1. | Khairthal | 84.68 | 12.68 | 3.31 |
| 2. | Nuh | 87.16 | 12.26 | 0.54 |
| 3. | Gurgaon | 56.29 | 22.38 | 21.04 |
| 4. | Jaipur | 45.72 | 28.17 | 25.77 |
| 5. | Kosi | 67.71 | 12.82 | 26.67 |
| 6. | Agra | 38.62 | 28.65 | 36.67 |
| 7. | Kaman | 35.38 | 37.04 | 34.39 |
| 8. | Fatehpur Sikri | 49.12 | 25.44 | 25.39 |
| 9. | Punahana | 41.99 | 57.93 | 0.00 |
| 10. | F. P. Jhirka | 71.28 | 23.30 | 6.97 |
| 11. | Achhnera | 49.08 | 22.74 | 28.74 |
| 12. | Alwar | 76.04 | 10.17 | 13.50 |
| 13. | Sohna | 77.97 | 18.35 | 36.20 |
| 14. | Bandikui | 54.13 | 22.80 | 22.80 |
| 15. | Kherli | 72.23 | 13.96 | 13.37 |
| 16. | Mathura | 67.28 | 7.44 | 26.05 |
| 17. | Narela | 67.66 | 18.59 | 13.74 |
| 18. | Najafgarh | 60.05 | 22.81 | 17.33 |
| 19. | Faridabad | 58.00 | 22.00 | 20.00 |
| 20. | Ballabgarh | 67.00 | 20.00 | 13.00 |
| 21. | Palwal | 88.00 | 8.00 | 4.00 |
| 22. | Hodel | 55.00 | 25.00 | 20.00 |
| 23. | Bharatpur | 51.00 | 30.00 | 19.00 |
| 24. | Nadbai | 60.00 | 25.00 | 15.00 |

*(Contd. on next page)*

| 1 | | 2 | 3 | 4 |
|---|---|---|---|---|
| 25. | Bhusawar | 63.00 | 21.00 | 16.00 |
| 26. | Mahwa | 63.00 | 22.00 | 15.00 |
| 27. | Nagar | 53.00 | 23.00 | 24.00 |
| 28. | Deeg | 51.00 | 26.00 | 23.00 |
| 29. | Dausa | 65.00 | 15.00 | 20.00 |
| 30. | Chomu | 78.00 | 12.00 | 10.00 |
| 31. | Kotputli | 80.00 | 8.00 | 12.00 |
| 32. | Rewari | 86.00 | 9.00 | 5.00 |
| 33. | Pataudi | 56.00 | 29.00 | 15.00 |
| 34. | Tauru | 83.00 | 10.00 | 7.00 |

**Table No. 3.5**

**Seasonal Variations in Marketed Surplus of Barley**

| *Sl. No.* | *Name of Mandi* | *Post harvest Period* | *Intermediate Period* | *Lean Period* |
|---|---|---|---|---|
| | *1* | *2* | *3* | *4* |
| 1. | Khairthal | 66.84 | 26.20 | 6.70 |
| 2. | Nuh | 62.41 | 23.55 | 14.02 |
| 3. | Gurgaon | 46.74 | 30.74 | 22.27 |
| 4. | Jaipur | 35.53 | 33.84 | 30.60 |
| 5. | Kosi | 68.93 | 16.22 | 14.83 |
| 6. | Agra | 24.06 | 38.82 | 37.08 |
| 7. | Kaman | 59.90 | 23.75 | 16.32 |
| 8, | Fatehpur Sikri | 59.34 | 20.83 | 19.79 |
| 9. | Punahana | 63.35 | 28.09 | 8.51 |
| 10. | F. P. Jhirka | 50.67 | 19.03 | 30.24 |
| 11. | Achhnera | 31.99 | 45.71 | 22.25 |
| 12. | Alwar | 53.94 | 32.15 | 13.68 |
| 13. | Sohna | 74.81 | 16.10 | 8.90 |
| 14. | Bandikui | 33.08 | 35.10 | 31.62 |
| 15. | Kherli | 60.90 | 24.08 | 14.70 |
| 16. | Mathura | 42.17 | 26.71 | 31.08 |
| 17. | Narela | 43.73 | 15.13 | 41.16 |
| 18. | Najafgarh | 40.35 | 24.84 | 34.81 |
| 19. | Faridabad | 47.00 | 30.00 | 22.00 |
| 20. | Ballabgarh | 61.01 | 30.02 | 9.00 |
| 21. | Palwal | 67.89 | 15.01 | 17.10 |
| 22. | Hodel | 66.05 | 20.00 | 14.00 |
| 23. | Bharatpur | 45.00 | 30.00 | 25.00 |
| 24. | Nadbai | 63.10 | 27.30 | 9.70 |

*(Contd. on next page)*

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 25. | Bhusawar | 61.00 | 30.00 | 9.00 |
| 26. | Mahwa | 47.00 | 33.00 | 20.00 |
| 27. | Nagar | 65.00 | 25.00 | 20.00 |
| 28. | Deeg | 51.00 | 35.00 | 14.00 |
| 29. | Dausa | 34.00 | 38.00 | 28.00 |
| 30. | Chomu | 34.00 | 40.00 | 26.00 |
| 31. | Kotputli | 54.00 | 36.00 | 10.00 |
| 32. | Rewari | 65.00 | 25.00 | 10.00 |
| 33. | Pataudi | 61.00 | 20.00 | 19.00 |
| 34. | Tauru | 70.00 | 18.00 | 12.00 |

**Table No. 3.6**

**Seasonal Variations in Marketed Surplus of Sarson**

| *Sl. No.* | *Name of Mandi* | *Post harvest Period* | *Intermediate Period* | *Lean Period* |
|---|---|---|---|---|
| | *1* | *2* | *3* | *4* |
| 1. | Khairthal | 69.40 | 19.00 | 11.40 |
| 2. | Nuh | 69.80 | 19.40 | 12 00 |
| 3. | Gurgaon | 41.35 | 41.06 | 17.60 |
| 4. | Hodel | 65.02 | 14.60 | 20.30 |
| 5. | Agra | 29.37 | 31.34 | 39 24 |
| 6. | Kaman | 66.29 | 19.75 | 13.96 |
| 7. | Fatehpur Sikri | 55.27 | 34.63 | 10.04 |
| 8. | Punahana | 63.55 | 25.24 | 11.46 |
| 9. | F.P. Jhirka | 37.39 | 36.56 | 25.96 |
| 10. | Achhnera | 61.10 | 22.32 | 16.46 |
| 11. | Alwar | 54.82 | 20 04 | 17.70 |
| 12. | Sohna | 73.68 | 19.27 | 6.97 |
| 13. | Kherli | 65.94 | 21.05 | 12.90 |
| 14. | Mathura | 42.77 | 25.40 | 31.71 |
| 15. | Narela | 42.59 | 36.42 | 20.99 |
| 16. | Najafgarh | 51.49 | 19.35 | 29.17 |
| 17. | Faridabad | 46.00 | 34.00 | 20.00 |
| 18. | Ballabgarh | 57.00 | 23.00 | 20.00 |
| 19. | Palwal | 72.00 | 18.00 | 10.00 |
| 20. | Kosi | 64.00 | 26.00 | 10.00 |
| 21. | Bharatpur | 58.00 | 22.00 | 20.00 |
| 22. | Nadbai | 63.00 | 27.00 | 10.00 |
| 23. | Bhusawar | 63.00 | 20.00 | 17.00 |
| 24. | Mahwa | 60.00 | 20.00 | 20 00 |

*(Contd. on next page)*

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 25. | Nagar | 51.00 | 26.00 | 23.00 |
| 26. | Deeg | 55.00 | 30.00 | 15.00 |
| 27. | Bandikui | 57.00 | 23.00 | 20.00 |
| 28. | Dausa | 60.00 | 18.00 | 22.00 |
| 29. | Jaipur | 48.00 | 22.00 | 30.00 |
| 30. | Chomu | 58.00 | 22.00 | 20.00 |
| 31. | Kotputli | 62.00 | 18.00 | 20.00 |
| 32. | Rewari | 65.00 | 20.00 | 15.00 |
| 33. | Pataudi | 57.00 | 23.00 | 20.00 |
| 34. | Tauru | 72.00 | 18.00 | 10.00 |

**Table No. 3.7**

**Seasonal Variations in Marketed Surplus of Gram**

| *Sl. No.* | *Name of Mandi* | *Post harvest Period* | *Intermediate Period* | *Lean Period* |
|---|---|---|---|---|
| | *1* | *2* | *3* | *4* |
| 1. | Khairthal | 67.17 | 19.35 | 14.27 |
| 2. | Nuh | 58.73 | 27.80 | 12.41 |
| 3. | Gurgaon | 46.39 | 38.57 | 14.54 |
| 4. | Jaipur | 60.44 | 23.20 | 16.24 |
| 5. | Kosi | 90.00 | 5.54 | 4.42 |
| 6. | Agra | 20.62 | 38.11 | 41.21 |
| 7. | Kaman | 53.37 | 34.11 | 12.43 |
| 8. | Fatehpur Sikri | 63.62 | 17.55 | 16.78 |
| 9. | Punahana | 49.98 | 44.03 | 5.93 |
| 10. | F.P. Jhirka | 54.27 | 37.58 | 8.08 |
| 11. | Achhnera | 54.93 | 30.19 | 14.93 |
| 12. | Alwar | 59.20 | 24,50 | 16.06 |
| 13. | Sohna | 61.39 | 28.23 | 10.22 |
| 14. | Bandikui | 44.69 | 30.50 | 24.60 |
| 15. | Kherli | 64.35 | 21.16 | 14.25 |
| 16. | Mathura | 64.58 | 23.39 | 13.04 |
| 17. | Narela | 77.65 | 16.99 | 5.36 |
| 18. | Najafgarh | 79.40 | 16.91 | 3.69 |
| 19. | Faridabad | 62.00 | 28.00 | 10.00 |
| 20. | Ballabgarh | 53.00 | 27.00 | 20.00 |
| 21. | Palwal | 61.00 | 18.00 | 21.00 |
| 22. | Hodel | 70.00 | 15.00 | 15.00 |
| 23. | Bharatpur | 59.00 | 21.00 | 20.00 |
| 24. | Deeg | 58.00 | 22.00 | 20.00 |

*(Contd. on next page)*

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 25. | Nagar | 56.00 | 20.00 | 24.00 |
| 26. | Nadbai | 64.00 | 18.00 | 18.00 |
| 27. | Bhusawar | 54.00 | 25.00 | 21.00 |
| 28. | Mahwa | 65.00 | 20.00 | 15.00 |
| 29. | Dausa | 62.00 | 18.00 | 20.00 |
| 30. | Chomu | 59.00 | 21.00 | 20.00 |
| 31. | Kotputli | 63.00 | 17.00 | 20.00 |
| 32. | Rewari | 64.00 | 19.00 | 17.00 |
| 33. | Pataudi | 63.00 | 20.00 | 17.00 |
| 34. | Tauru | 61.00 | 20.00 | 19.00 |

**Table 3.8**

**Seasonal Variations in Marketed Surplus of Bajra**

| *Sl. No.* | *Name of Mandi* | *Post harvest Period* | *Intermediate Period* | *Lean Period* |
|---|---|---|---|---|
| | *1* | *2* | *3* | *4* |
| 1. | Khairthal | 56.59 | 41.90 | 0.89 |
| 2. | Nuh | 94.42 | 1.47 | 4.13 |
| 3. | Gurgaon | 90.57 | 5.00 | 4.43 |
| 4. | Jaipur | 61.30 | 22.62 | 16.09 |
| 5. | Kosi | 87.85 | 1.27 | 10.88 |
| 6. | Agra | 79.43 | 1.74 | 18.88 |
| 7. | Kaman | 90.25 | 2.26 | 7.49 |
| 8. | Fatehpur Sikri | 92.46 | 0.00 | 7.56 |
| 9. | Punahana | 74.99 | 0.00 | 25.00 |
| 10. | Achhnera | 83.81 | 9.87 | 6.30 |
| 11. | F.P. Jhirka | 90.91 | 4.39 | 4.70 |
| 12. | Alwar | 78.82 | 18.64 | 2.53 |
| 13. | Sohna | 58.70 | 35.69 | 5.61 |
| 14. | Bandikui | 60.14 | 33.44 | 9.80 |
| 15. | Mathura | 69.94 | 9.29 | 20.77 |
| 16. | Narela | 63.15 | 27.59 | 9.61 |
| 17. | Najafgarh | 80.30 | 8.15 | 11.54 |
| 18. | Faridabad | 85.00 | 10.00 | 5.00 |
| 19. | Ballabgarh | 75.00 | 20.00 | 5.00 |
| 20. | Palwal | 76.00 | 14.00 | 10.00 |
| 21. | Hodel | 82.00 | 10.00 | 8.00 |
| 22. | Nagar | 84.00 | 8.00 | 8.00 |
| 23. | Deeg | 89.00 | 6.00 | 5.00 |
| 24. | Bharatpur | 88.00 | 6.00 | 6.00 |

*(Contd. on next page.)*

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 25. | Nadbai | 74.00 | 16.00 | 10.00 |
| 26. | Bhusawar | 72.00 | 18.00 | 10.00 |
| 27. | Kherli | 76.00 | 14.00 | 10.00 |
| 28. | Mahwa | 69.00 | 16.00 | 15.00 |
| 29. | Dausa | 60.00 | 25.00 | 15.00 |
| 30. | Chomu | 70.00 | 16.00 | 14.00 |
| 31. | Kotputli | 66.00 | 17.00 | 17.00 |
| 32. | Rewari | 75.00 | 15.00 | 10.00 |
| 33. | Pataudi | 85.00 | 8.00 | 7.00 |
| 34. | Tauru | 76.00 | 12.00 | 12.00 |

wheat arrives in 4 busiest months of post harvest priod and 33 per cent is distributed over the remaining 8 months. 69 per cent of barley at Kosi is recorded within the post harvest busiest months and the remaining 31 per cent is spread over other 8 months. The cumulative figures for different months at Mathura is not so high. At Fatehpur Sikri where wheat is of some significance, 38 per cent comes in first two busiest months after its harvest. In case of Achhnera we have three months arrivals, April, May and June which are the busiest months for most of the rabi crops. 45 per cent of its wheat comes in this season. Highest arrival of sarson is in May (35 per cent of the total annual) and almost 50 per cent within first two busiest months.

The seasonal arrival trends of wheat and sarson are similar. For both the commodities, the arrival is 48 per cent during the first three busiest months in the post harvest period. The arrival of sarson starts one month earlier as compared to wheat. Bajra, arhar and gur are the commodities which show well marked seasonal trends in their arrival. More than 59 per cent of the total annual arrival of these commodities is recorded during the first three busiest months.

Map No. 3.7 shows that in the major part of the region more than 70 per cent of bajra comes within the post harvest period. Leaving apart sohna mandi,this makes a continuous zone in the north-east, south and central part of the region. Sohna, Tauru and Palwal are the only mandis in the region where three commodities out of five form more than 70 per cent of the arrivals. During the post harvest season, wheat, sarson and bajra are the three commodities which record more than 70 per cent arrival at Palwal and Tauru. Barley, wheat and sarson together form more than 70 per cent market arrivals at Sohna mandi. Rewari, Nuh, Hodel, Alwar, Kherli, Kosi and Najafgarh are the mandis where two crops bajra and gram record contribute more than 70 per cent to the total arrivals. Wheat and bajra constitute more than 70 per cent of arrivals in Rewari, Nub, Hodel, Alwar and Kherli.

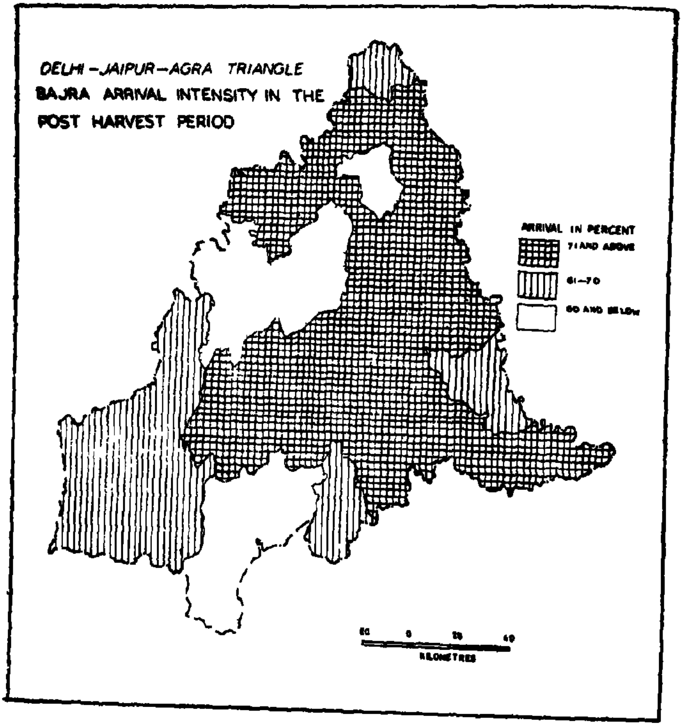

DELHI-JAIPUR-AGRA TRIANGLE
BAJRA ARRIVAL INTENSITY IN THE
POST HARVEST PERIOD
ARRIVAL IN PERCENT
71 AND ABOVE
61—70
60 AND BELOW
0
KILOMETRES

Fig. : 3.7

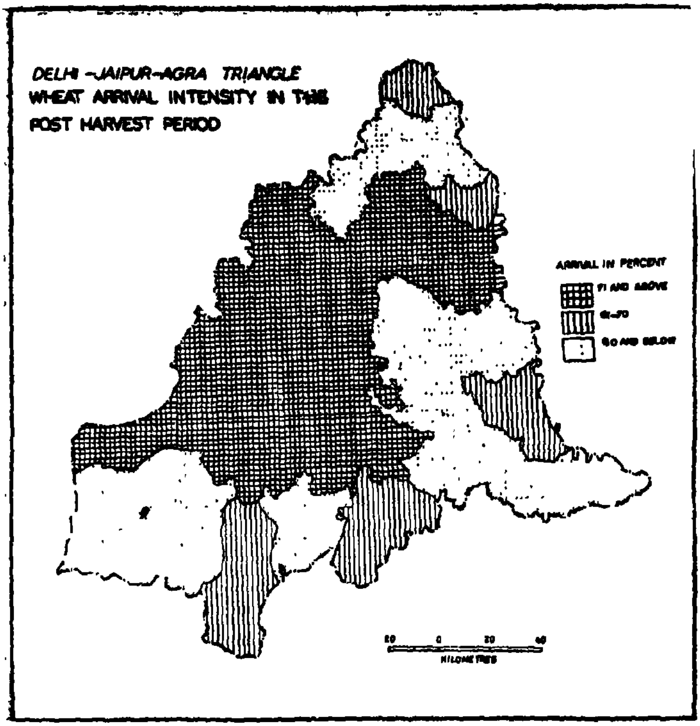

DELHI –JAIPUR–AGRA TRIANGLE
WHEAT ARRIVAL INTENSITY IN THE
POST HARVEST PERIOD
ARRIVAL IN PERCENT

Fig. : 3.8

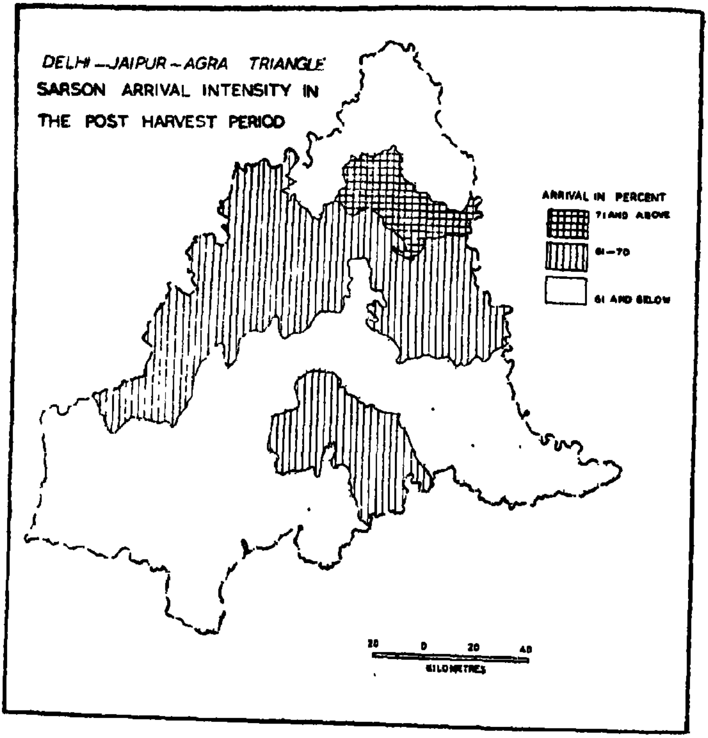

DELHI—JAIPUR—AGRA TRIANGLE
SARSON ARRIVAL INTENSITY IN
THE POST HARVEST PERIOD
ARRIVAL IN PERCENT
71 AND ABOVE
61—70
61 AND BELOW
20 0 20 40
KILOMETRES

Fig. : 3.9

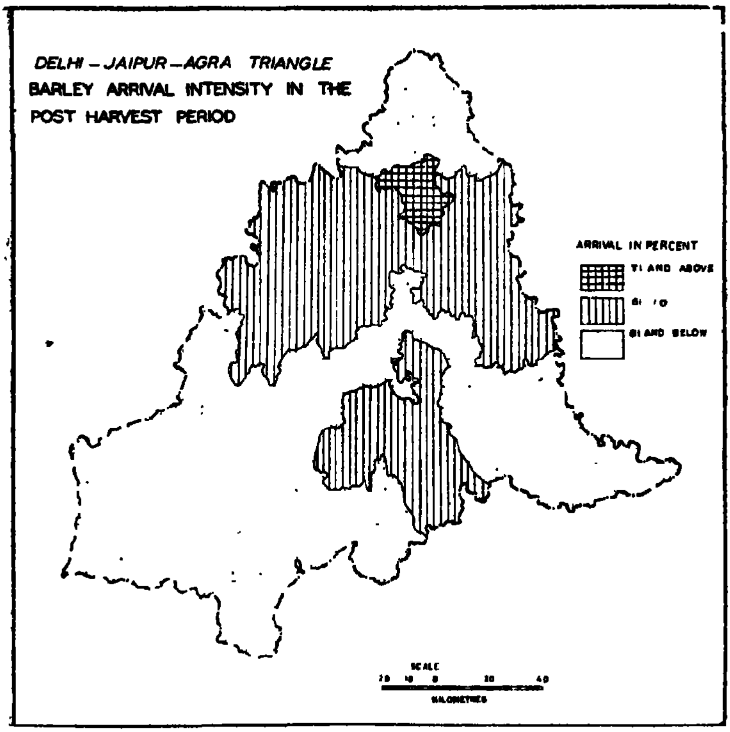

DELHI – JAIPUR – AGRA TRIANGLE
BARLEY ARRIVAL INTENSITY IN THE
POST HARVEST PERIOD
ARRIVAL IN PERCENT
71 AND ABOVE

Fig. : 3.10

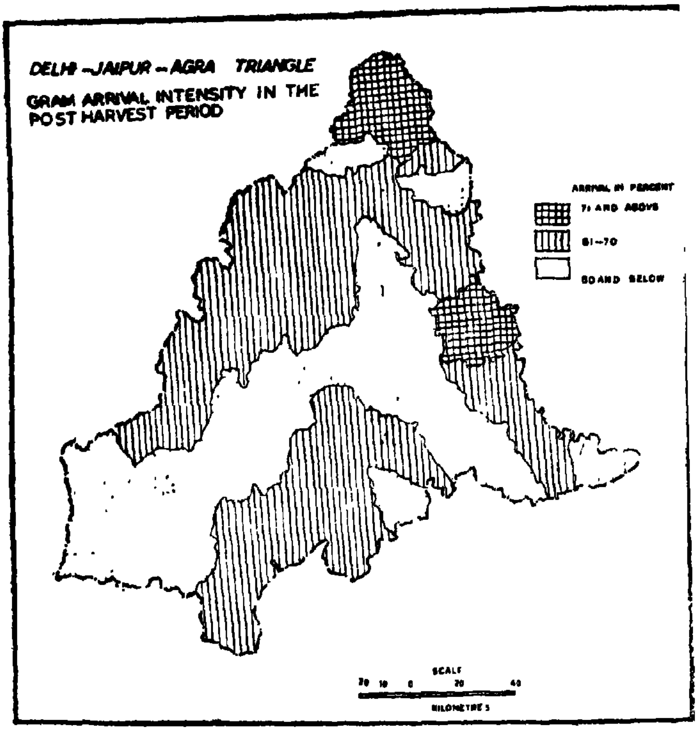

DELHI –JAIPUR – AGRA TRIANGLE
GRAM ARRIVAL INTENSITY IN THE
POST HARVEST PERIOD
61–70

Fig. : 3.11

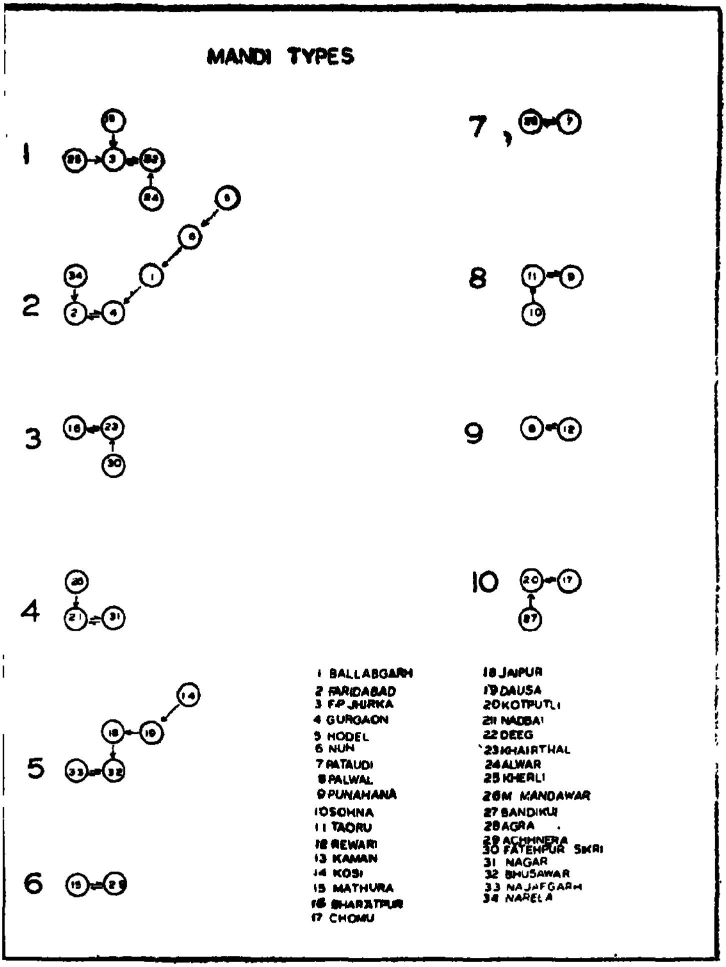

MANDI TYPES
1
2
3
4
5
6
7
8
9
10
1 BALLABGARH
2 FARIDABAD
3 F.P JHIRKA
4 GURGAON
5 HODEL
6 NUH
7 PATAUDI
8 PALWAL
9 PUNAHANA
10 SOHNA
11 TAORU
12 REWARI
13 KAMAN
14 KOSI
15 MATHURA
16 BHARATPUR
17 CHOMU
18 JAIPUR
19 DAUSA
20 KOTPUTLI
21 NADBAI
22 DEEG
23 KHAIRTHAL
24 ALWAR
25 KHERLI
26 M MANDAWAR
27 BANDIKUI
28 AGRA
29 ACHHNERA
30 FATEHPUR SIKRI
31 NAGAR
32 BHUSAWAR
33 NAJAFGARH
34 NARELA

Fig. : 3.12

**Table**

**Association of**

**(On the basis of different**

| | | *1* | *2* | *3* | *4* | *5* | *6* |
|---|---|---|---|---|---|---|---|
| 1. | Ballabgarh | 1.000 | 0.988 | —0.225 | 0.994 | 0.873 | —0.201 |
| 2. | Faridabad | 0.988 | 1.000 | —0.156 | 0.999 | 0.804 | —0.181 |
| 3. | F.P. Jhirka | —0.225 | —0.156 | 1.000 | —0.165 | —0.113 | 0.896 |
| 4. | Gurgaon | 0.994 | 0.999 | —0.165 | 1.000 | 0.830 | —0.171 |
| 5. | Hodel | 0.873 | 0.809 | —0.113 | 0.830 | 1.000 | 9.090 |
| 6. | Nuh | —0.201 | —0.181 | 0.896 | —0.171 | 0.090 | 1.000 |
| 7. | Pataudi | 0.445 | —0.243 | —0.138 | —0.205 | —0.362 | 0.244 |
| 8. | Palwal | 0.980 | 0.957 | —0.099 | 0.966 | 0.941 | —0.027 |
| 9. | Punahana | 0.109 | 0.112 | 0.826 | 0.124 | 0.392 | 0.946 |
| 10. | Sohna | 0.210 | 0.176 | 0.682 | 0.188 | 0.511 | 0.774 |
| 11. | Tauru | 0.174 | 0.163 | 0.787 | 0 176 | 0.461 | 0.888 |
| 12. | Rewari | —0.216 | —0.206 | 0.913 | —0.196 | —0.081 | 0.970 |
| 13. | Kaman | —0.287 | —0.214 | 0.997 | —0.225 | —0.188 | —0.873 |
| 14. | Kosi | 0.640 | 0.611 | 0.434 | 0.627 | 0.844 | 0.579 |
| 15. | Mathura | 0.645 | 0.677 | 0.593 | 0.676 | 0.663 | 0.548 |
| 16. | Bharatpur | —0.145 | —0.079 | —0.667 | —0.084 | —0.051 | 0.865 |
| 17. | Chomu | —0.139 | —0.071 | —0.280 | —0.074 | —0.347 | —0.255 |
| 18. | Jaipur | 0.797 | 0.765 | —0.530 | 0.782 | 0.731 | —0.331 |
| 19. | Dausa | 0.649 | 0.707 | —0.488 | 0.693 | 0.477 | —0.622 |
| 20. | Kotputli | —0.439 | —0.378 | —0.052 | —0.357 | —0.546 | —0.011 |
| 21. | Nadbai | —0.160 | —0.008 | 0.969 | —0,079 | —0.121 | 0.855 |
| 22. | Deeg | —0.222 | —0.152 | 0.9997 | —0.161 | —0.119 | 0.887 |
| 23. | Khairthal | —0.114 | —0.048 | 0.992 | —0.056 | —0.012 | 0.881 |
| 24 | Alwar | —0.203 | —0.133 | 0.99968 | —0.142 | —0.097 | 0.892 |
| 25. | Kherli | —0.274 | —0.222 | 0.991 | —0.226 | —0.098 | 0.938 |
| 26. | M. Mandawar | —0.083 | —0.003 | 0.959 | —0.011 | —0.026 | 0.880 |
| 27. | Bandikui | —0.359 | —0.225 | 0.198 | —0.254 | —0.701 | 0.596 |
| 28. | Agra | 0.394 | 0.466 | 0.800 | 0.457 | 0.377 | 0.691 |
| 29. | Achhnera | 0.736 | 0.773 | 0.493 | 0.771 | 0.703 | 0.443 |
| 30. | Fatehpur Sikri | 0.112 | 0.073 | 0.970 | 0.066 | 0.035 | 0.876 |
| 31. | Nagar | —0.188 | —0.090 | 0.961 | —0.103 | —0.167 | 0.832 |
| 32. | Bhusawar | 0.975 | 0.990 | —0.236 | 0.989 | 0.764 | —0.256 |
| 33. | Najafgarh | 0.988 | 0.996 | —0.242 | 0.995 | 0.794 | —0.261 |
| 34. | Narela | 0.981 | 0.997 | —0.147 | 0.997 | 0.798 | —0.164 |

**No 3.9**

**Mandi Centres**

**agricultural Commodities)**

| *7* | *8* | *9* | *10* | *11* | *12* | *13* |
|---|---|---|---|---|---|---|
| 0.445 | 0.980 | 0.108 | 0.210 | 0.174 | —0.216 | —0.287 |
| —0.243 | 0.957 | 0.112 | 0.176 | 0.163 | —0.206 | —0.214 |
| —0.138 | —0.099 | 0.826 | 0.682 | 0.787 | 0.913 | 0.997 |
| —0.205 | 0.966 | 0.124 | 0.188 | 0.176 | —0.198 | —0.225 |
| —0.362 | 0.941 | 0.392 | 0.511 | 0.461 | —0.081 | —0.188 |
| 0.244 | —0.027 | 0.946 | 0.774 | 0.888 | 0.970 | —0.873 |
| 1.000 | 0.029 | 0.255 | 0.424 | 0.307 | 0.275 | —0.166 |
| 0.029 | 1.000 | 0.286 | 0.387 | 0.353 | —0.076 | —0.168 |
| 0.255 | 0.286 | 1.000 | 0.902 | 0.981 | 0.934 | 0.783 |
| 0.424 | 0.387 | 0.902 | 1.000 | 0.968 | 0.857 | 0.639 |
| 0.307 | 0.353 | 0.981 | 0.968 | 1.000 | 0.919 | 0.743 |
| 0.275 | —0.076 | 0.934 | 0.857 | 0.919 | 1.000 | 0.895 |
| —0.166 | —0.168 | 0.783 | 0.639 | 0.743 | 0.895 | 1.000 |
| 0.312 | 0.777 | 0.811 | 0.855 | 0.857 | 0.586 | 0.364 |
| —0.115 | 0.738 | 0.758 | 0.762 | 0.796 | 0.566 | 0.538 |
| —0.152 | —0.022 | 0.827 | 0.727 | 0.809 | 0.903 | 0.986 |
| —0.429 | —0.246 | —0.403 | —0.752 | —0.567 | —0.464 | —0 267 |
| 0.061 | —0.522 | —0.118 | —0.167 | —0.136 | —0.459 | —0.589 |
| —0.634 | 0.496 | —0.489 | —0.550 | —0.508 | —0.712 | —0.503 |
| —0.319 | —0.506 | —0.244 | —0.629 | —0.429 | —0.426 | —0 209 |
| —0.292 | —0.059 | 0.778 | 0.552 | 0.704 | 0.822 | 0.964 |
| —0.152 | —0.099 | 0.818 | 0.678 | 0.781 | 0.907 | 0.997 |
| —0.142 | 0.013 | 0.851 | 0.738 | 0.828 | 0.909 | 0.983 |
| —0.147 | —0.078 | 0.829 | 0.689 | 0.793 | 0.875 | 0.995 |
| —0.008 | —0.131 | 0.861 | 0.724 | 0.822 | 0.955 | 0.986 |
| —0.241 | 0.021 | —0.385 | 0.594 | 0.751 | 0.836 | 0.946 |
| —0.835 | —0.469 | 0.067 | —0.567 | —0.402 | —0.172 | 0.244 |
| 0.981 | 0.484 | —0.345 | 0.697 | 0.792 | 0.684 | 0.763 |
| —0.184 | 0.807 | 0.671 | 0.666 | 0.705 | 0.444 | 0.436 |
| —0.129 | 0.141 | 0.885 | 0.780 | 0.869 | 0.887 | 0.952 |
| —0.331 | —0.095 | 0.745 | 0.506 | 0.664 | 0.796 | 0.959 |
| —0.287 | 0.924 | 0.021 | 0.053 | 0.056 | —0.304 | —0.289 |
| —0.287 | 0.944 | 0.029 | 0.098 | 0.081 | —0.291 | —0.299 |
| —0.261 | 0.949 | 0.119 | 0.154 | 0.159 | —0.205 | —0.205 |

| *14* | *15* | *16* | *17* | *18* | *19* | *20* |
|---|---|---|---|---|---|---|
| 0.640 | 0.645 | —0.146 | —0.139 | 0.797 | 0.649 | —0.439 |
| 0.611 | 0.677 | —0.079 | —0.071 | 0.765 | 0.707 | —0.373 |
| 0.434 | 0.593 | —0.667 | —0.280 | —0.530 | —0.488 | —0.052 |
| 0.627 | 0.676 | —0.084 | —0.074 | 0.782 | 0.693 | —0 375 |
| 0.844 | 0.663 | —0.051 | —0.347 | 0.731 | 0.477 | —0.546 |
| 0.579 | 0.548 | 0.865 | —0.255 | —0.331 | —0.622 | —0 011 |
| 0.312 | —0.115 | —0.152 | —0.429 | 0.061 | —0.634 | —0·319 |
| 0.777 | 0.738 | —0.022 | —0.246 | —0.522 | 0.496 | —0.506 |
| 0.811 | 0.758 | 0.827 | —0.403 | – 0.118 | —0.439 | —0.244 |
| 0.855 | 0.762 | 0 727 | —0.752 | —0.167 | —0.550 | —0.629 |
| 0 857 | 0.796 | 0.809 | —0.567 | —0.136 | —0.508 | —0 426 |
| 0.586 | 0.566 | 0.903 | —0.464 | —0.459 | —0.712 | —0.209 |
| 0.364 | 0.538 | 0.986 | —0.267 | —0.589 | —0.503 | —0 026 |
| 1.000 | 0.899 | 0.485 | —0 502 | 0.352 | —0.958 | —0.546 |
| 0.899 | 1.000 | 0 657 | —0.417 | 0.219 | 0.089 | —0 479 |
| 0 485 | 0.657 | 1.000 | —0.368 | —0.518 | —0.459 | —0.163 |
| —0.502 | —0.417 | —0.368 | 1.000 | 0.338 | 0.522 | 0.935 |
| 0.352 | 0.219 | —0.518 | 0.338 | 1.000 | 0.696 | 0 047 |
| —0.958 | 0.089 | —0.459 | 0.522 | 0.696 | 1.000 | 0.199 |
| —0.026 | —0.546 | —0.163 | 0.935 | 0.047 | 0.199 | 1.000 |
| 0.397 | 0.599 | 0.250 | —0 064 | —0.400 | —0.302 | 0 125 |
| 0.428 | 0.595 | 0.994 | —0.286 | —0.538 | —0.480 | —0.059 |
| 0.579 | 0.682 | 0 998 | —0.350 | —0.473 | —0.441 | —0.151 |
| 0.448 | 0 611 | 0.994 | —0.289 | —0.520 | —0.473 | —0 067 |
| 0.450 | 0.554 | 0.976 | —0.317 | —0 545 | —0.588 | —0.064 |
| 0.477 | 0.653 | 0.940 | —0.063 | —0.316 | —0.385 | 0.108 |
| —0 573 | —0.228 | 0.144 | 0.701 | —0.253 | 0.349 | 0.736 |
| 0.746 | 0.935 | 0.837 | —0.261 | —0.003 | 0.009 | —0.240 |
| 0.875 | 0.988 | 0.559 | —0.327 | 0.339 | 0.235 | —0.437 |
| 0.617 | 0.769 | 0.985 | —0.368 | —0.365 | —0.375 | —0.202 |
| 0.348 | 0.567 | 0.938 | 0 025 | —0.416 | —0.285 | 0.165 |
| 0.523 | 0.594 | —0.169 | 0.058 | 0.821 | 0.786 | —0.260 |
| 0.551 | 0.608 | —0.168 | —0.021 | 0.802 | 0.750 | —0.276 |
| 0.604 | 0.674 | —0.077 | 0.654 | 0.787 | 0 726 | —0.342 |

| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|
| —0.160 | —0.222 | —0.114 | —0.203 | —0.274 | —0.083 | —0.359 |
| —0.068 | —0.152 | —0.048 | —0.133 | —0.222 | —0.003 | —0.225 |
| 0.969 | 0.9997 | 0.992 | 0.9968 | 0.991 | 0.959 | 0.198 |
| —0.079 | —0.161 | 0.056 | —0.142 | —0.226 | —0.011 | —0.254 |
| —0.121 | —0.119 | —0.012 | —0.097 | —0.098 | —0.026 | —0.701 |
| 0.855 | 0.887 | 0.881 | 0.892 | 0.938 | 0.880 | 0.546 |
| —0.292 | —0.152 | —0.142 | —0.147 | —0.008 | —0.241 | —0.835 |
| —0.059 | —0.099 | 0.013 | —0.078 | —0.131 | 0.021 | —0.469 |
| 0.778 | 0.818 | 0.851 | 0.829 | 0.861 | —0.385 | 0.067 |
| 0.552 | 0.678 | 0.738 | 0.689 | 0.724 | 0.594 | —0.567 |
| 0.704 | 0.781 | 0.828 | 0.793 | 0.822 | 0.751 | —0.402 |
| 0.822 | 0.907 | 0.909 | 0.875 | 0.955 | 0.836 | —0.172 |
| 0.964 | 0.997 | 0.983 | 0.995 | 0.986 | 0.946 | 0.244 |
| 0.397 | 0.428 | 0.519 | 0.448 | 0.450 | 0.477 | —0.573 |
| 0.599 | 0.595 | 0.682 | 0.611 | 0.554 | 0.653 | —0.228 |
| 0.950 | 0.994 | 0.998 | 0.994 | 0.976 | 0.940 | 0.144 |
| —0.064 | —0.286 | —0.350 | —0.289 | —0.317 | —0.067 | —0.701 |
| —0.400 | —0.538 | —0.473 | —0.520 | —0.545 | —0.316 | —0.253 |
| —0.302 | —0.480 | —0.441 | —0.473 | —0.588 | —0.285 | 0.349 |
| 0.125 | —0.059 | —0.751 | —0.067 | —0.064 | 0.108 | 0.736 |
| 1.000 | 0.969 | 0.957 | 0.970 | 0.942 | 0.994 | 0.363 |
| 0.969 | 1.000 | 0.993 | 0.9997 | 0.988 | 0.957 | 0.205 |
| 0.957 | 0.993 | 1.000 | 0.995 | 0.977 | 0.953 | 0.133 |
| 0.970 | 0.9997 | 0.995 | 1.000 | 0.998 | 0.961 | 0.193 |
| 0.942 | 0.988 | 0.977 | 0.988 | 1.000 | 0.935 | 0.111 |
| 0.994 | 0.957 | 0.953 | 0.961 | 0.935 | 1.000 | 0.303 |
| 0.363 | 0.205 | 0.133 | 0.193 | 0.111 | 0.302 | 1.000 |
| 0.835 | 0.803 | 0.857 | 0.814 | 0.750 | 0.864 | —0.069 |
| 0.528 | 0.495 | 0.587 | 0.513 | 0.504 | 0.585 | —0.190 |
| 0.943 | 0.971 | 0.992 | 0.982 | 0.953 | 0.950 | 0.072 |
| 0.998 | 0.961 | 0.944 | 0.961 | 0.929 | 0.988 | 0.413 |
| —0.122 | 0.233 | —0.136 | —0.214 | —0.306 | —0.058 | —0.149 |
| —0.148 | —0.238 | —0.137 | —0.220 | —0.308 | —0.083 | —0.218 |
| —0.044 | —0.143 | —0.043 | 0.072 | —0.267 | 0.022 | —0.184 |

| *28* | *29* | *30* | *31* | *32* | *33* | *34* |
|---|---|---|---|---|---|---|
| 0.394 | 0.736 | 0.112 | —0.188 | 0.975 | 0.988 | 0.981 |
| 0.466 | 0.773 | 0.073 | —0.090 | 0.990 | 0.996 | 0.997 |
| 0.800 | 0.493 | 0.970 | 0.961 | —0.236 | —0.242 | —0.149 |
| 0.467 | 0.771 | 0.066 | —0.103 | 0.989 | 0.995 | 0.997 |
| 0.277 | 0.703 | 0.037 | —0.167 | 0.764 | 0.794 | 0.798 |
| 0.691 | 0.443 | 0.876 | 0.832 | —0.256 | —0.261 | —0.164 |
| 0.981 | —0.184 | —0.129 | —0.331 | —0.287 | —0.287 | —0.261 |
| 0.484 | 0.807 | 0.141 | —0.095 | 0.924 | 0.944 | 0.949 |
| —0.345 | 0.671 | 0.885 | 0.745 | 0.021 | 0.029 | 0.119 |
| 0.697 | 0.666 | 0.780 | 0.506 | 0.053 | 0.a98 | 0.154 |
| 0.792 | 0.705 | 0.869 | 0.664 | 0.046 | 0.081 | 0.159 |
| 0.684 | a.444 | 0.887 | 0.796 | —0.304 | —0.291 | —0.205 |
| 0.763 | 0.436 | 0.952 | 0.959 | —0.289 | —0.299 | —0.205 |
| 0.746 | 0.875 | 0.617 | 0.348 | 0.523 | 0.551 | 0.604 |
| 0.935 | 0.988 | 0.769 | 0.567 | 0.594 | 0.608 | 0.674 |
| 0.137 | 0.559 | 0.985 | 0.948 | —0.169 | —0.168 | —0.077 |
| —0.261 | —0.327 | —0.368 | —0.025 | 0.058 | —0.021 | 0.654 |
| —0.003 | 0.339 | —0.365 | —0.416 | 0.821 | 0.802 | 0.787 |
| 0.009 | 0.235 | —0.375 | —0.285 | 0.786 | 0.750 | 0.726 |
| —0.240 | —0.437 | —0.202 | 0.165 | —0.26[illegible] | —0.276 | —0.342 |
| 0.835 | 0.528 | 0.943 | 0.998 | —0.122 | —0.148 | —0.044 |
| 0.803 | 0.495 | 0.971 | 0.961 | —0.233 | 0.238 | —0.143 |
| 0.857 | 0.587 | 0.992 | 0.944 | —0.136 | —0.137 | —0.043 |
| 0.814 | 0.513 | 0.982 | 0.961 | —0.214 | 0.220 | 0.072 |
| 0.750 | 0.504 | 0.953 | 0.929 | —0.306 | —0.308 | —0.265 |
| 0.864 | 0.585 | 0.950 | 0.998 | —0.058 | —0.083 | 0.022 |
| —0.069 | —0.190 | 0.072 | 0.413 | —0.149 | —0.218 | —0.184 |
| 1.000 | 0.906 | 0.910 | 0.815 | 0.392 | 0.287 | 0.475 |
| 0.906 | 1.000 | 0.684 | 0.497 | 0.704 | 0.713 | 0.773 |
| 0.910 | 0.684 | 1.000 | 0.925 | —0.018 | —0.016 | 0.078 |
| 0.815 | 0.497 | 0.925 | 1.000 | —0.139 | —0.168 | —0.065 |
| 0.392 | 0.704 | —0.017 | —0.139 | 1.000 | 0.996 | 0.994 |
| 0.387 | 0.813 | —0.016 | —0.168 | 0.996 | 1.000 | 0.9939 |
| 0.475 | 0.773 | 0.078 | —0.065 | 0.994 | 0.9939 | 1.000 |

## SECTION—III

### 3.7 Mandi Types based on Similar Arrival :

Based on the pettern of arrival of commodities and the similarity of commodities, ten mandi types have emerged. Type one, two and five include 5 to 6 mandis each. Then remaining groups have only 2 or 3 mandis in each type. The larger number of grouping shows that the proportionate share of different agricultural commodities very largely in the different parts of the region. Type 2 has six mandis i.e. Hodel, Palwal, Ballabgarh, Gurgaon, Faridabad and Narela which means that this is the largest group of mandis in the northern port of the region contributing similar commodities in about similar proportion in their mandi yards. This represents well irrigated part of the region. In contrast type 1 represents dry farming region (Kherli, Kaman, F. Jhirka, Deeg and Alwar). Type 5 has a peculiar combination of mandis located on the different peripheral sides. It does't have a contiguous area. These are Kosi, Dausa, Bhusawar, Jaipur and Najafgarh. Type 3 includes Bharatpur, Khairthal and Fatehpur Sikri. Mahwa Mandawar, Nagar and Nadbai are of type 4. Type 6, 7 and 9 have only two mandis each, i.e., Mathura and Achhnera, Agra and Pataudi, Nuh and Rewari respectively.

### 3.8 Conclusion :

Generally, the district headquarters or important regional centres, associated with large population size, have big marketed surplus. In the north, particularly in Haryana the mandi network is relatively thick and their hinterlands are small hence per mandi marketed surplus is less. Wheat has maximum contribution i.e., 36.37 per cent towards total marketed surplus. Sarson, barley and gram add 20.35, 23.47 and 14.01 per cent respectively in the total quantity of marketed surplus. Agra and Jaipur receive 15.00 and 20.18 per cent wheat respectively to the total marketed surplus. 17.44 per cent sarson of the region's gram and 18 per cent of total barley is received at Jaipur mandi.

The mandis where wheat has either negative or low growth rate there barley recorded very high positive annual growth rate, where barley has low growth rate or negative growth rate, there wheat has shown very high growth rate. Agra, being an exception. Sarson and gram have shown quite similar growth trends. All the mandis which have negative growth rate for sarson arrival, also have negative growth for gram, Chomu being an exception. Most of the mandis of negative growth for gram and sarson are located in the fertile and well irrigated belt along the Yamuna river.

We notice well marked seasonal trends in the arrival of various commodities. However, in two largest mandis i.e., Jaipur and Agra seasonal picture could not emerge prominently because of large secondary arrivals from outside the region even in the off season. Most of the other mandis could receive more than 50 per cent of wheat in the post-harvest-season. 58.47 per cent of the region's total wheat, 57 per cent sarson, 50 per cent barley, 77.27 per cent bajra, and 60 per cent gram is recorded in the post-havest season.

On the basis of similar arrival patterns, 10 mandi groups have been identified. These grougs indicate their association with the nature of agricultural practices in the region.

# 4

# Transport Network and Marketed Surplus

## 4.1 Introduction :

This chapter brings out the relationship between the structural indices of transport network and the quantity of marketed surplus of agricultural produce. It contains six major sections and each section has two/three sub-sections. First section relates to marketed wheat surplus and transport network nodality. Its three sub-sections are (i) residuals from the regression of marketed wheat on total road capacity; here results of simple regession of marketed wheat on total road capacity have been interpreted and the unexplained proportion of wheat arrivals has been discussed. The total road capacity has been selected, because, it is the most important contributor among the transport variables in explaining the variations in the wheat arrivals. In the second sub-section, i.e. stepwise multiple regression analysis of marketed wheat surplus and the indices of transport network nodality, the explanatory capacity of transport network variables has been tested. Thus here the variance in the arrival of agricultural produce has been explained by the selected transport network indices. These transport variables are direct connectivity, aggregate travel distance, tortuosity ratio, local degree for roads, local degree ‹ railways and total road capacity. The third sub-section

deals with the simple regression exercise of marketed wheat on mandi accessibility*. The spatial patterns of residuals from the marketed wheat surplus on mandi accessibility have been depicted.

Sections two to six bring out the relationship of surplus barley, sarson, gram, bajra and marketed surplus of all the 5 major commodities with transport network nodality. The method of analysis followed in all the five sections is the same and is similar to the one used in the first section.

**4.2 Methodology** :

Simple and step-wise multiple regression have been used to study the relationship between transport network structure and arrival of agricultural marketed surplus. Indices of transport network efficiency have been taken as independent variables. These graph-theoretic measures of transport network have to explain, individually as well as collectively (only those indices which have significant contribution in explaining variance in the marketed surplus), the spatial variations in the arrival of agricultural commodities. Before going for regression analysis a correlation matrix was prepared to see the simple association between transport network development indices and arrival size of marketed surplus. There are two sets of structural indices (table no. 4.1). In set I, the indices are for areal units (i.e. mandi hinterlands) and the indices in set II pertain to the individual points in the transport network (i.e. they represent the nodal accessibility of mandi centres). As evident from table no. 4.1. the relationship between the network structural indices of set I and the quantity of various commodities sold in the mandi is generally poor. Whereas in set II (which shows the association between indices of nodal accessibility and marketed surplus), strong association is noticed. Keeping in view the insignificant statistical relation-

*Mandi accessibility is the composite index of direct connectivity aggregate travel distance, tortuosity ratio, local degree (roads) local degree (railways) and total road capacity as discussed in chapter two.

**Table No. 4.1**

**Coefficient of Correlation Between the Indices of Transport Network Structure and Arrival of Various Commodities in the Delhi-Jaipur-Agra Triangle**

| *Structural indices of Transport Network* | *1* *Wheat* | *2* *Sarson* | *3* *Gram* | *4* *Bajra* | *5* *Barley* | *6* *(1-5)* |
|---|---|---|---|---|---|---|
| **SET-I** | | | | | | |
| 1. Cyclomatic Number | 0.403 | 0.572 | 0.252 | 0.369 | 0.295 | 0.492 |
| 2. Alpha | 0.262 | 0.308 | —0.011 | 0.119 | 0.032 | 0.225 |
| 3. Gama | —0.157 | —0.154 | —0.130 | —0.138 | —0.162 | —0.180 |
| 4. Beta | 0 334 | 0 370 | 0.052 | 0.220 | 0.241 | 0.329 |
| 5. Eta | 0.137 | 0.056 | 0·373 | 0.352 | 0.208 | 0.212 |
| 6. Theta | 0.153 | 0.057 | 0.421 | 0.377 | 0.206 | 0.230 |
| 7. Road Density* | —0.127 | —0.266 | —0.387 | —0.315 | —0.178 | —0.280 |
| 8. C.I. (1-7) | 0.029 | 0.003 | —0.193 | —0 085 | —0.133 | —0 058 |
| **SET-II** | | | | | | |
| 9. Direct Connectivity | 0.241 | 0.165 | 0.035 | 0.037 | 0.149 | 0.170 |
| 10. Tortuousity Ratio | 0.070 | —0.166 | —0.230 | —0 097 | —0.223 | —0.126 |
| 11. Aggregate Travel Distance | 0.424 | —0 015 | 0.634 | 0.596 | 0.417 | 0.399 |
| 12. Local Degree (Road) | 0.519 | 0.410 | 0.375 | 0.403 | 0 404 | 0.519 |
| 13. Local Degree (Rail) | 0.606 | 0.461 | 0.425 | 0.549 | a.565 | 0.617 |
| 14. Total Road Capacity | 0.725 | 0.336 | 0.618 | 0 660 | 0.550 | 0.663 |

C.I.=Composite Index

*Road density is not based on graph-theoretic measures of connectivity. It is rather a traditional method of measuring accessibility.

Table No. 4.2

**Correlation Matrix**

**Coefficient of Correlation Between Transport Network Indices and Marketed Surplus (Agricultural Produce)**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Direct Connectivity | 1.00 | | | | | | | | | | | |
| 2. Tortuosity Ratio | .356 | 1.00 | | | | | | | | | | |
| 3. Aggregate Travel Distance | —.415 | —.143 | 1.00 | | | | | | | | | |
| 4. Local Degree (Road) | .556 | .101 | .110 | 1.00 | | | | | | | | |
| 5. Local Degree (Rail) | .194 | —.015 | .354 | .547 | 1.00 | | | | | | | |
| 6. Total Road Capacity | .459 | .151 | .427 | .778 | .559 | 1.00 | | | | | | |
| 7. Arrival of Wheat | .028 | .067 | .509 | .392 | .509 | .585 | 1.00 | | | | | |
| 8. Arrival of Sarson | .197 | .170 | .047 | .416 | .468 | .337 | .387 | 1.00 | | | | |
| 9. Arrival of Gram | —.014 | —.231 | .586 | .372 | .430 | .607 | .707 | .505 | 1.00 | | | |
| 10. Arrival of Bajra | .011 | —.096 | .577 | .390 | .530 | .647 | .823 | .512 | .912 | 1.00 | | |
| 11. Arrival of Barley | .196 | —.223 | .340 | .415 | .567 | .551 | .575 | .427 | .769 | .716 | 1.00 | |
| 12. Total Arrivals | .108 | —.109 | .458 | .481 | .608 | .647 | .891 | .654 | .886 | .924 | .806 | 1.00 |

ship, marketed surplus could not be regressed on the indices of set I (transport network structural indices which are used for areal units). Because of this statistical problem, the hypothesis that the efficient network system of a mandi hinterland contributes towards larger marketed surplus could not be tested with sophistication. Whereas, the marketed surplus has been regressed on the nodality indices (Set II) because of their statistically strong relationships at various levels of significance. To establish the above relationship, Pearson's Product Movement coefficient of correlation* has been worked out. The significance of the coefficient of correlations has been tested by the students' 't' test** as given below. After knowing the strength of relationship with the help of correlation coefficient we were interested in knowing how marketed surplus behaved in different mandis in relation to their levels of nodality. To state the nature of above relationship, the following regression equation*** has been used.

Where the constant a indicates the position of the intercept on the y axis, b indicates the slope of the regression line, and e an error term representing that which is not accounted for by the linear relationship. This is the way to estimate Y. By putting the value of transport network index value (X) in the regression equation, marketed surplus was predicted and denoted by $\hat{Y}$. The difference between actual marketed surplus (Y) and the estimated marketed surplus ($\hat{Y}$) represent the residuals from the regression. In order to have relative picture from the residuals they have been divided by the actual marketed surplus. Thus, the residuals given here are $\frac{\hat{Y}-Y}{Y} \times 100$.

$$* \; r = \frac{\Sigma XY - \frac{\Sigma X \Sigma Y}{N}}{\sqrt{\Sigma X^2 - \frac{(\Sigma X)^2}{N}}\sqrt{\Sigma Y^2 - \frac{(\Sigma Y)^2}{N}}}$$

$$** \; t = \sqrt{\frac{n-2}{1-r^2}}$$

with n−2 degrees of freedom.

***$Y = a + bx + e$

These residuals were mapped for the variables which have statistically significant relationships. The residuals from the regression have been used to identify the mandi nodes where beside the road transport development, the arrivals of marketed surplus are affected by other forces. The intensity of these forces depends upon the magnitude of the residuals. Stepwise regression analysis has been used in the study to see the explanatory capacity of transport indices if taken together. Residuals from stepwise multiple regression were plotted to know the regional disparities in unexplained variance in the marketed surplus.

## SECTION—I

### 4.3 Marketed Wheat Surplus and Transport Network Nodality :

#### 4.3.1 Residuals from the regression of marketed wheat on total road capacity :

The variation in the total marketed wheat is very much sensitive to the total road capacity in the region. Around 34 per cent variance in the arrival of wheat is explained by this explanatory factor only, as denoted by coefficient of determination ($R^2 = .34$). The regression* coefficient, which is significant at 1 per cent level of significance clearly indicates that with every unit of additional increase in total road capacity, wheat arrivals further increases by 6429.4 quintals. There are 16 observations (mandis) which lie below the predicted line and the remaining 18 are above it. Except Ballabgarh and Faridabad all the regulated mandis along river Yamuna have lowest positive deviations from the actual wheat arrival figures (Map No. 4.1). Ballabgarh and Faridabad fall in the lowest category of negative residuals. Whole of the belt along Yamuna is well irrigated and most fertile hence it is a wheat surplus zone. Inspite of the fact that some of the mandi towns have exceptionally high accessibility level, the predicted arrivals could not be higher than the arrivals in reality. The next continuous zone extending from north to south in the heart of the region

* $Y = a + bx = -46777.3 + 6429.4$

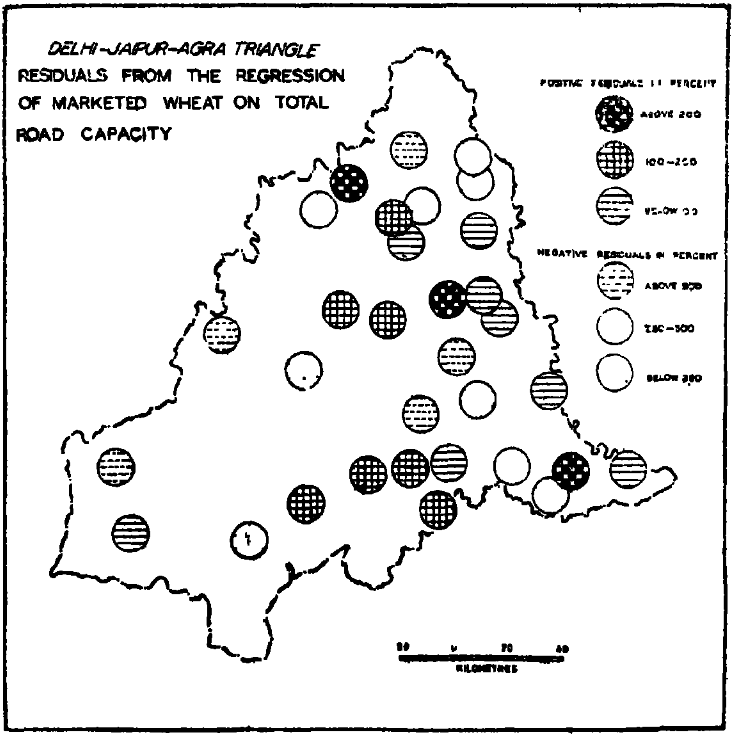

DELHI-JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE REGRESSION
OF MARKETED WHEAT ON TOTAL
ROAD CAPACITY
ABOVE 200

**Fig. : 4.1**

**Table No. 4.3**

**Stepwise Regression Analysis of Wheat Arrivals on Transport Network Nodality**

| *Variable* | *Regression Coefficient* | *t* | *R* | *R2* | *Increase in R2* | $\bar{R}$ | *F* | *S.E. of Estimate* |
|---|---|---|---|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| **Step—1** | | | | | | | | |
| $X_6$ | 6429.400 | 2.080* | .585 | .342 | — | .585 | 16.643* | 98535.113 |
| **Step—2** | | | | | | | | |
| $X_6$ | 4943.443 | 2.983* | | | | | | |
| $X_3$ | 37.900 | 2.098*** | .651 | .424 | .082 | .637 | 11.406* | 93683.231 |
| **Step—3** | | | | | | | | |
| $X_6$ | 3753.530 | 2.008**** | | | | | | |
| $X_3$ | 34.248 | 1.895**** | .675 | .456 | .032 | .648 | .8367* | 92581.053 |
| $X_5$ | 16125.714 | 1.320 | | | | | | |
| **Step—4** | | | | | | | | |
| $X_6$ | 5084.582 | 1.858**** | | | | | | |
| $X_3$ | 10.909 | .709 | .681 | .464 | .008 | .640 | 6.273** | 93439.991 |
| $X_5$ | 16531.370 | 1.339 | | | | | | |
| $X_1$ | 2699.476 | .672 | | | | | | |

(*Contd. on next page*)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Step—5 | | | | | | | | |
| $X_6$ | 5082.336 | 1.8383**** | | | | | | |
| $X_3$ | 19.158 | .675 | | | | | | |
| $X_5$ | 17356.176 | 1.384 | .687 | .471 | .008 | .637 | 4.994 | 94422.592 |
| $X_1$ | 3344.959 | .799 | | | | | | |
| $X_2$ | 331022.547 | .632 | | | | | | |

* Significant at 1% level of significance
** Significant at 2% level of significance
*** Significant at 5% level of significance
**** Significant at 10% level of significance

is that of relatively high positive residuals. Pataudi, Punahana and Achhnera are the mandis where the arrivals are much more than the predictions. The study area also has some of the mandis where the difference between actual wheat arrivals and expected wheat arrivals predicted by total road capacity is more than 500 per cent in negative direction. These are Chomu, Kotputli, Gurgaon, Kaman and Nagar, which are well spaced and do not form any continuous region.

### 4.3.2 Stepwise multiple regression analysis of marketed wheat surplus and indices of transport network nodality :

This exercise has been taken up to test the explanatory capacity of transport network variables, i.e. how much variation in wheat arrivals in a mandi can be explained by the selected transport network indices, (direct connectivity, aggregate travel distance, tortuosity ratio, local degree roads, local degree for railways, and total road capacity). As exhibited by table No. 4.4. except direct connectivity and tortuosity ratio, all the above variables have significant association with the arrival size of wheat at various levels of significance. The closest association of wheat arrivals is seen with total road

**Table No. 4.4**

**Correlation Coefficient (r) between Wheat arrivals and Selected Transport Accessibility variables for the region**

| *S. No.* | *Variable* | *r value* |
|---|---|---|
| 1. | Direct Connectivity | .028 |
| 2. | Tortuosity Ratio | .067 |
| 3. | Aggregate Travel Distance | .509 |
| 4. | Local Degree (Road) | .392 |
| 5. | Local Degree (Rail) | .509 |
| 6. | Total Road Capacity | .585 |

capacity. Hence, total road capacity has been put in the Ist step of regression. This alone could explain 34 per cent variance in the wheat arrivals. The aggregate travel distance is the second variable to be added in the second step, which adds 8 per cent to the explained variation. The next, though less important, to be included in the model in the 3rd step is local degree rail, which contributes around 3.2 per cent. Thus, the above three variables of transport network nodality could explain 46.4 per cent variations in the marketed wheat. The procedure of stepwise regıession was stopped after 3rd step. Direct connectivity and tortuosity ratio could not be included in the model because these do not contribute significantly towards the explained variation as reflected by negligible increase in $R^2$ and declining trend of R values after 3rd step and increasing trend of standard error of estimate. Upto 3rd step the multiple correlation coefficient is significant at 1 per cent level of significance. The final regression equation is given below :

$$Y = -170458.9 + 3753.5\, x_6 + 34.2\, x_3 + 16125.7 x_5$$

This shows how the variance in the wheat arrivals could be partly attr ibuted to variation with respect to each of the transport variables and also accounting for some in common. The above regression equation tells that every additional unit increase of local degree (rail) adds 16125.7 quintals of wheat arrivals as against an increase of 3753.5 quintals with the additional unit of total road capacity. Every additional km. in aggregate travel distance incraeses 34.2 quintals of wheat in the mandi. The regression coefficient for total road capacity and local degree rail are significant at 5 per cent level of significance.

The result of multiple correlation (R) is .67, which shows the magnitude of relationship between 3 independent variables and one dependent (Y) variable. The coefficient of determination ($R^2$) is .456 which indicates that almost 45.6 per cent of the variance in the wheat arrivals is accounted for by these 3 variables. F test has been performed to see whether the combined relationship of above mentioned independent indicators of accessibility and wheat arrivals is significant or not.

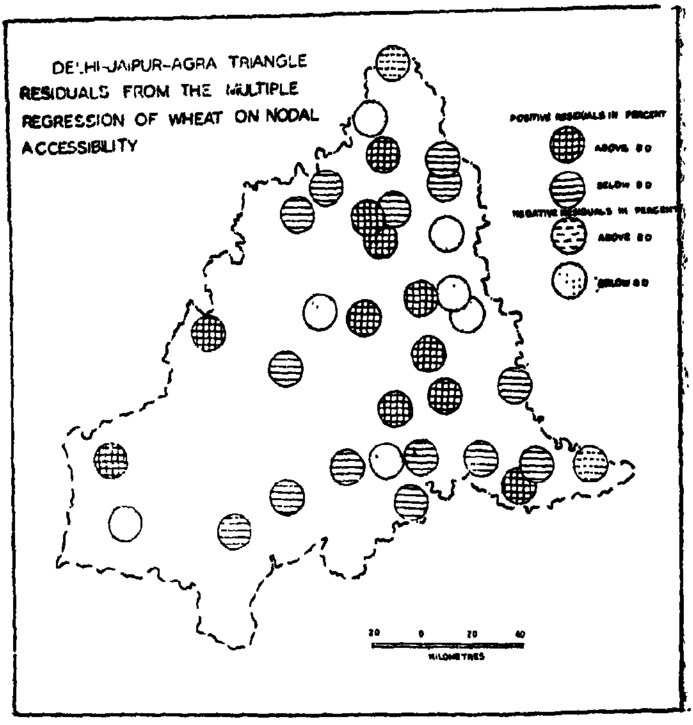

DELHI-JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE NOTIPLE
REGRESSION OF WHEAT ON NODAL
ACCESSIBLITY
20 0 20 40
KILOMETRES

**Fig. : 4.2**

The calculated value of F is 8.367, which is significant at 1 per cent level of significance. The unexplained proportion of wheat arrivals has been represented through the relative residuals in Map No. 4.2.

**4.3.3 Residuals from the regression of marketed wheat on mandi accessibility :**

Arrival of wheat in the mandis and their accessibility are positively correlated (r- 0.6813) with very high lavel of significance. More than 46 per cent of the variance in the wheat arrivals are explained by its degree of accessibility, as denoted by the coefficient of determination ($R^2$=0.4624). six mandis (i.e. Kotputli, Tauru, Punahana, Khairthal, Kherli and Bhusawar) of the region have more than 100 per cent relative residuals. Bandikui and Agra also have moderately high positive residuals. In all these mandis, the actual wheat arrivals are more than the predicted. Rewari, Deeg, Nadbai and Chomu have moderately high negative residuals from the regression. Jaipur, Mahwa, Mandawar, Ferozepur-Jhirka, Kosi, Hodel and Palwal have least positive residuals. Faridabad, Ballabgarh, Nuh, Mathura, Achhnera, Alwar and Dausa have the least negative residuals (Map No. 4-3). In other words, these are the mandis where accessibility is the most effective explanatory variable. While considering individual agricultural products, the most probable variables to explain the residual of these commodities is the acreage under different crops, percentage of irrigated area and the quality of land in different parts of the region. Whatever the predicted arrival of a commodity in a particular mandi, very high negative residuals of that commodity are observed if that particular commodity is not grown in its hinterland in proportion to its transport levels. Suppose, there are mandis with very little arrival of wheat and their transport level is also very low, their arrival prediction will be low, hence magnitude of residuals will be much less. The comparison of Map No. 4.3 of this chapter and Map No. 3.1 depicting first major commodities in the mandis in Chapter-3 shows that generally the differences between predicted wheat arrivals and actual wheat arrivals is very less in the areas where wheat acreage is very high. In this

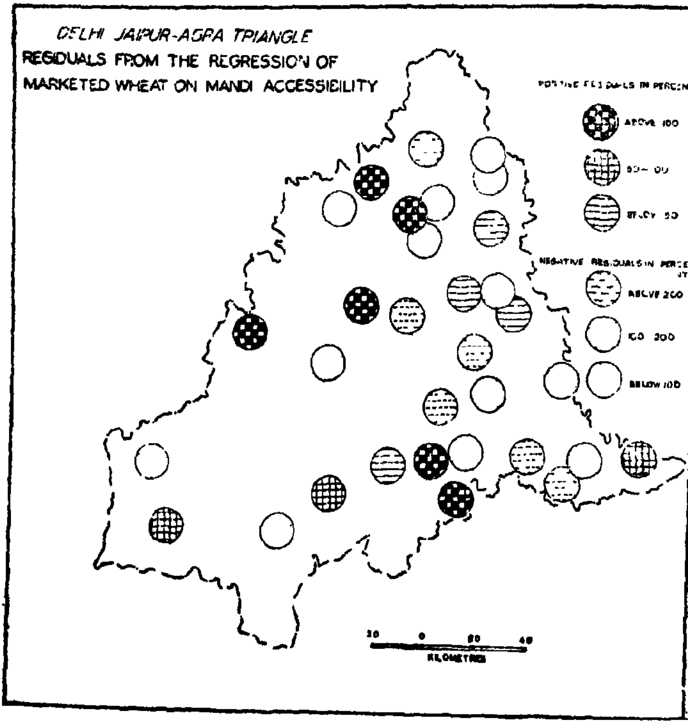

DELHI JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE REGRESSION OF
MARKETED WHEAT ON MANDI ACCESSIBILITY
ABOVE 100
NEGATIVE RESIDUALS IN PERCENT
ABOVE 200
BELOW 100
KILOMETRES

Fig. : 4.3

context, Jaipur is a typical case. Here the wheat acreage is moderately high but it receives sufficiently high amount of secondary wheat arrivals from far distant parts.

## SECTION II

### 4.4 Marketed Surplus of Barley and Transport Network Indices:

### 4.4.1 Stepwise multiple regression of barley on Selected transport nodality indices :

**Table No. 4. 5**

**Correlation Coefficient—( r ) Between Marketed Barley Arrivals and Selected Transport Accessibility—Variables**

| *S. No.* | *Variables* | *r Values* |
|---|---|---|
| 1. | Direct Connectivity | .196 |
| 2. | Tortuosity Ratio | —.223 |
| 3. | Aggregate Travel Distance | .340 |
| 4. | Local Degree (Road) | .415 |
| 5. | Local Degree (Rail) | .567 |
| 6. | Total Road Capacity | .551 |

The last three sets of associations are significant. The stepwise regression continued upto the 3rd step. Local degree rail was obviously the most important contributor which was taken in the first step of the model. The $R^2$ for local degree rail is .321, meaning thereby that this explains 32 per cent variance in the marketed barley. Total road capacity and tortuosity ratio increases the $R^2$ by .08 and .075 respectively. The collective contribution of these three variables is 48 per cent towards explained variation. Direct connectivity and aggregate travel distance have been dropped from the model because they do not add much to the explained variation. The final regression equation* shows that with every unit change in local degree rail and total road capacity, there is an increase

* $Y = 394756.7 + 12927.2 X_5 + 2303.8 X_6 - 510933.0 X_2$

**Table No. 4.6**

**Stepwise Regression Analysis of Barley Arrivals on Transport Network Nodality**

| *Variable* | *Regression Coefficient* | t | *R* | *R2* | *Increase in R2* | $\overline{R}$ | *F* | *S.E. of estimate* |
|---|---|---|---|---|---|---|---|---|
| *1* | 2 | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| **Step--1** | | | | | | | | |
| $X_5$ | 21792.192 | 3.892* | .567 | .321 | — | .5667 | 15.144* | 51788.920 |
| **Step—2** | | | | | | | | |
| $X_5$ | 14478.474 | 2.246*** | .633 | | .080 | .618 | 10 372 | 49433.838 |
| $X_6$ | 1935.735 | 2 030 | | | | | | |
| **Step—3** | | | | | | | | |
| $X_5$ | 12927.186 | 2.094*** | | | | | | |
| $X_6$ | 2303.795 | 2.494** | .690 | .476 | .075 | .665 | 9.077* | 47004.607 |
| $X_2$ | —510933.022 | —2.071*** | | | | | | |
| **Step—4** | | | | | | | | |
| $X_5$ | 13048.028 | 2.081*** | | | | | | |
| $X_6$ | 2144.077 | 2.101*** | .692 | .479 | .003 | .653 | 6.655** | 47679.534 |
| $X_2$ | —544398.811 | —2.061*** | | | | | | |
| $X_1$ | 556.555 | .396 | | | | | | |

*(Contd. on next page)*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Step—5 | | | | | | | | |
| $X_5$ | 12561.258 | 1.959 | | | | | | |
| $X_6$ | 1620 839 | 1.147 | | | | | | |
| $X_2$ | −5504 0.103 | −2.056*** | .696 | .448 | .005 | .642 | 5.253 | 48270.817 |
| $X_1$ | 1 23.671 | .665 | | | | | | |
| $X_3$ | 7.870 | .542 | | | | | | |

* Significant at 1% level of significance
** Significant at 2% level of significance
*** Significant at 5% level of significance
**** Significant at 10% level of significance

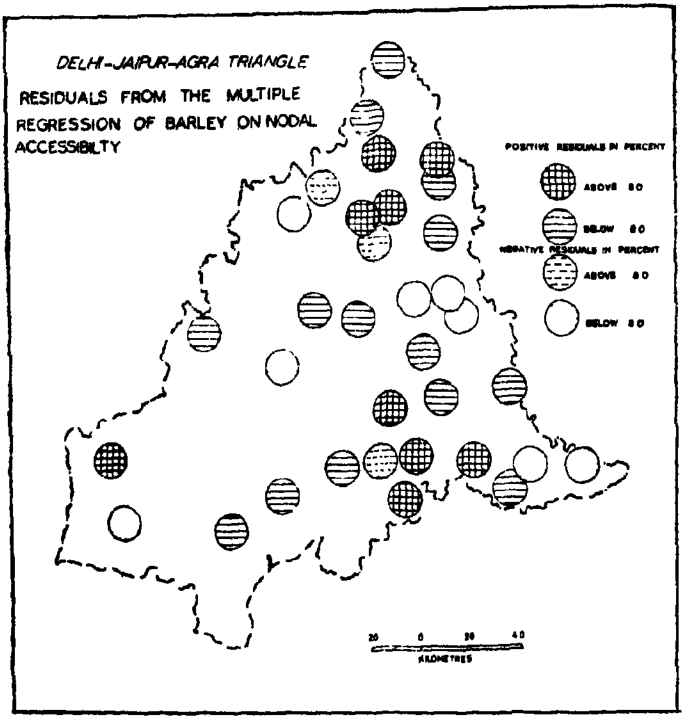

DELHI-JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE MULTIPLE REGRESSION OF BARLEY ON NODAL ACCESSIBILTY
POSITIVE RESIDUALS IN PERCENT
ABOVE
BELOW
NEGATIVE RESIDUALS IN PERCENT
ABOVE
BELOW
KILOMETRES

**Fig. : 4.4**

in marketed barley by 12927 and 2304 quintals respectively. With a unit change in tortuosity ratio, the arrival of barley is effected by 510933 quintals in the negative direction.

The multiple correlation coefficient (R) at 3rd step is 0.69 and the coefficient of determination is 0.48, thus explaining 48 per cent variation in the arrival of barley. The F test reveals that the multiple correlation is significant at 1 per cent level of significance. This supports the assumption that if more than one variable of transport network is taken, they may explain larger portion of variance in the marketed surplus of barley. The residuals from the multiple regression are plotted on Map No. 4.4.

**4.4.2 Residuals from Regression of marketed barley on mandi Accessibility :**

The index of mandi accessibility could explain only 30 per cent variations in the marketed surplus of barley. Nineteen mandis lie below the predicted regression line. The magnitude of negative residuals for some of the mandis is very high, whereas it is generally low for positive residuals. In the later case it never exceeds 89 per cent whereas in negative side there are five regulated mandis which have even more than 600 per cent residuals. Nuh, Hodel, Agra, and Bandikui are the mandis where difference between predicted barley amount and actual amount sold in the market is below 25 per cent, least in the positive scale. In southern and south-western parts, the deviations between predicted and actual arrivals are not much (Map No. 4.5). The patterns of relative residuals are sharply divided by Aravalli to the west of which, the mandis of highest positive residuals are located. This part of the region is most rugged and deprived of irrigation facilities. Most of the mandis located towards the east of the Aravalli have predicted values higher than the actual barley arrivals. Chomu is the only exception in the west which have very high negative residuals. The mandis which have nagative residuals, from 300 to 600 per cent, are Ballabgarh, Achhnera, Fatehpur Sikri, Bharatpur and Nadbai. Last four Mandis are concentrated in south-eastern corner of the region over Jaipur-Agra National highway.

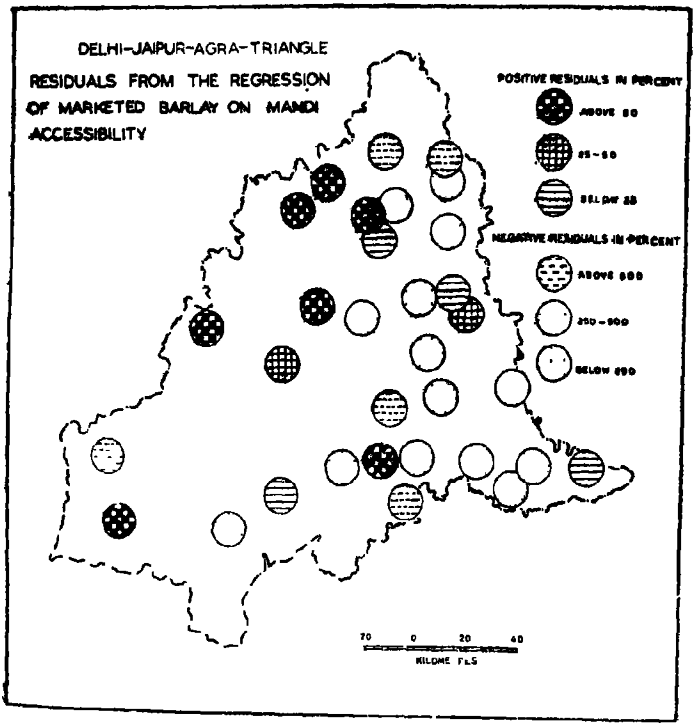

DELHI-JAIPUR-AGRA-TRIANGLE
RESIDUALS FROM THE REGRESSION OF MARKETED BARLAY ON MANDI ACCESSIBILITY
POSITIVE RESIDUALS IN PERCENT
NEGATIVE RESIDUALS IN PERCENT
KILOMETRES

Fig. : 4.5

## SECTION—III

### 4.5. Marketed Surplus of Sarson and Transport Network Nodality :

### 4.5.1 Stepwise multiple correlation and regression analysis of marketed sarson on transport network nodality :

Here an attempt has been made to show the impact of transport network variables on the arrival of sarson at different mandi centres in the region.

**Table No 4.7**

**Correlation Coefficients (r) between Sarson Arrivals and Selected Transport Network Nodality variables**

| *S. No.* | *Variables* | *r Value* |
|---|---|---|
| 1. | Direct Connectivity | .197 |
| 2. | Tortuosity Ratio | —.170 |
| 3. | Aggregate Travel Distance | —.047 |
| 4. | Local Degree (Road) | .416 |
| 5. | Local Degree (Rail) | .468 |
| 6. | Total Road Capacity | .337 |

Local degree rail ($X_5$) has the closest association with the arrival size of sarson. Because of this $X_5$ has been taken in the Ist step of the model. Though, it is the most important explanatory variable but could explain only 22 per cent variance in the arrival of this commodity. Aggregate travel distance, which is the second major contributor in increasing the $R^2$ value, accounts for 5.2 per cent variance in the arrival size. With the addition of tortuosity ratio in the model at 3rd step, $R^2$ increased by .039. The inclusion of total road capacity in the model increased the explanatory position of the model by 5 per cent as indicated by .050 increase in $R^2$. The addition of direct connectivity ($X_1$) does not contribute

**Table No. 4.8**

**Stepwise Regression Analysis of Sarson Arrivals on Transport Network Nodality**

| *Variable* | *Regression Coefficient* | *t* | *R* | *R2* | *increase in R* | $\bar{R}$ | *F* | *S.E. of estimate* |
|---|---|---|---|---|---|---|---|---|
| *1* | 2 | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| **Step—1** | | | | | | | | |
| $X_5$ | 17872.949 | 2.995* | .468 | .219 | — | .468 | 8.993* | 55118.607 |
| **Step—2** | | | | | | | | |
| $X_5$ | 21159.553 | 3.383* | | | | | | |
| $X_3$ | —16 984 | —1.466 | .521 | .271 | .052 | .498 | 5.770* | 54107.343 |
| **Step—3** | | | | | | | | |
| $X_5$ | 21470.477 | 3.470* | | | | | | |
| $X_3$ | —16.925 | —1.679 | .557 | .311 | .039 | .51598 | 4.508 | 53492.691 |
| $X_2$ | —365016.150 | —1.310 | | | | | | |
| **Step—4** | | | | | | | | |
| $X_5$ | 16396.283 | 2.361*** | | | | | | |
| $X_3$ | —22.179 | —2.116*** | | | | | | |
| $X_2$ | —470592.965 | —1.669 | .600 | .360 | .050 | .544 | 4.084 | 52412.873 |
| $X_6$ | 1639.171 | 1.500 | | | | | | |

(Contd. on next page)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Step—5 | | | | | | | | |
| $X_5$ | 16867.269 | 2.417*** | | | | | | |
| $X_3$ | —33.157 | —2.098 | | | | | | |
| $X_2$ | —404520.840 | —1.388 | .616 | .379 | .019 | .542 | 3.425 | 52535.182 |
| $X_6$ | 2643.942 | 1.718 | | | | | | |
| $X_1$ | —2167.502 | —.930 | | | | | | |

* Significant at 1% level of significance
** Significant at 2% level of significance
*** Significant at 5% level of significance
**** Significant at 10% level of significance

any thing as indicated by increased standard error of estimate and decreased $\bar{R}$ value. Thus the fifth step is excluded from the model.

In the following equation* regression coefficient of local degree rail and aggregate travel distance are significant at 3 per cent level. Specifically, the equation reveals that an additional unit change in aggregate travel distance, the quantity of sarson in the mandi centres varies by 22.18 quintals. Whereas a unit increase in local degree rail increases trade in sarson by 16396.28 quintals in the present given situation. The reason being that most of the quantity of sarson is transported to distant destinations, for which railway is the most economic mode of transport. Aggregate travel distance contributes negatively because higher the aggregate travel distance higher will be the distance of the mandi from the railway lines. Thus it has a negative influence. The contribution of direct connectivity, tortuosity ratio, local degree road and total road capacity is negligible from the statistical view point as reflected by their insignificant regression coefficients. But $X_6$ (total road capacity) has been included in the model, because upto this step, $\bar{R}$ increases and standard error of estimate decreases. It also increases $R^2$ by .050.

The multiple correlation has made it possible to establish the relationship between all selected transport accessibility variables together, and sarson arrival in the mandis. The coefficient of multiple correlation (R) is 0.60 at the 4th step. The coefficient of determination ($R^2$) is .36. This shows that these transport network efficiency indices, which measure the degree of disposal capacity, could hardly explain 36 per cent variation in the mandi arrival of sarson. The 'F' test shows that the association is significant at 5 per cent level of confidence. The residuals from the multiple regression are plotted on Map No. 4.6.

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* $Y = -459504.98 + 16396.28\, X_5 - 22.18\, X_3 - 470592.96\, X_2 + 1639.17\, X_6$

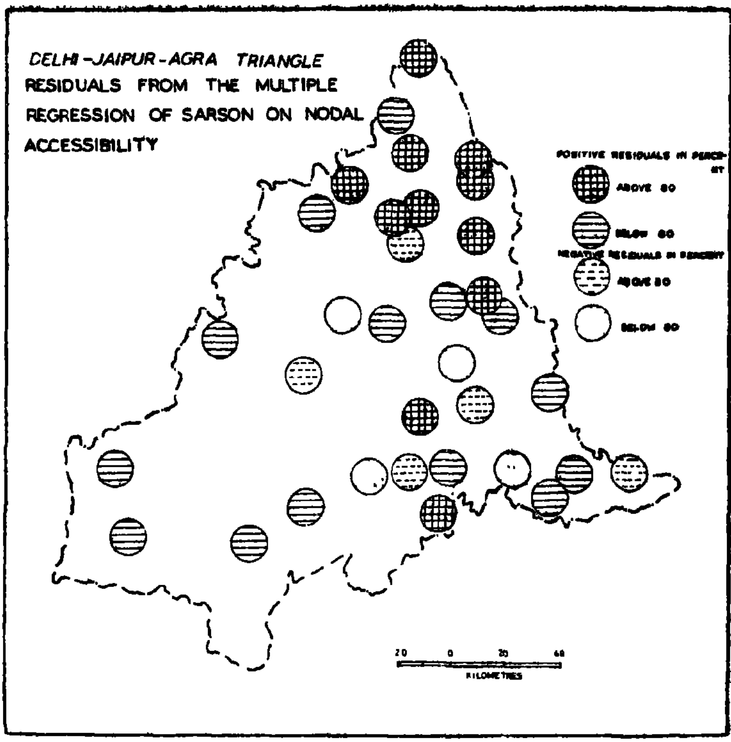

DELHI-JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE MULTIPLE
REGRESSION OF SARSON ON NODAL
ACCESSIBILITY

**Fig. : 4.6**

**4.5.2 Residuals from regression of marketed sarson on mandi accessibility :**

Mandi accessibility could explain only 20 per cent variance in the arrival of sarson in the region. All the three mandis of Alwar district are very important for arrival of sarson. These are the mandis where quantity of arrivals of sarson is much more than the estimated arrivals. Though very few mandis could exist in this area due to unfavourable natural conditions. These three mandis cover comparatively large areas. The mandis where actual sarson arrivals are moderately higher than the estimated are Rewari, Kaman, Deeg, Bharatpur, Nadbai and Mahwa-Mandawar (4.7). All the mandis which fall below the regression line are located only on the national highways. This again points out the fact that a high mandi accessibility and a relatively lower percentage of area under sarson cultivation are the reasons for this situation. Perhaps their hinterlands prefer to grow some other commodities due to economic profitability or on account of physical constraints like soil types, inadequate irrigation etc. The mandis, which are located nearest to the regression line (below or above it) do not make any pattern over the region. But all the mandis of Mewat which lie in Gurgaon district come under this category. Out of the five mandis which have minimum negative residuals, three like in Gurgaon district, the other two are Jaipur and Achhnera, located on the extremely south-eastern and south-western parts of the region.

## SECTION—IV

**4.6 Marketed Surplus of Gram and Transport Network Nodality :**

**4.6.1 Stepwise multiple regression analysis of gram arrival and indices of transport network nodality :**

The following table brings out the statistical relationship between the transport network variables and the gram arrivals. The table reveals that the last four variables have significant

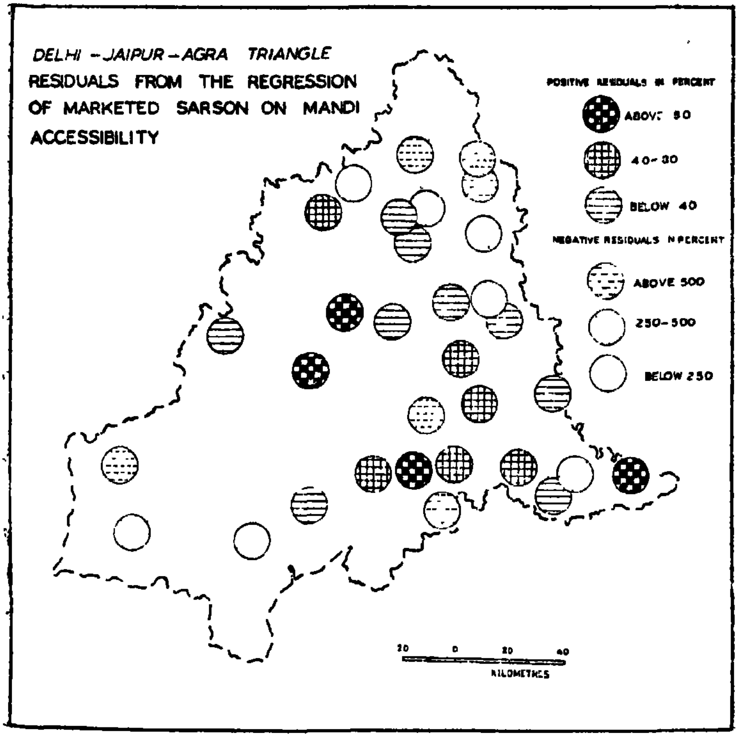

DELHI – JAIPUR – AGRA TRIANGLE
RESIDUALS FROM THE REGRESSION
OF MARKETED SARSON ON MANDI
ACCESSIBILITY
POSITIVE RESIDUALS IN PERCENT
ABOVE 80
40-80
BELOW 40
NEGATIVE RESIDUALS IN PERCENT
ABOVE 500
250-500
BELOW 250
20 0 20 40
KILOMETRES

Fig. : 4.7

correlation with the value of arrivals. In the stepwise regression, the total road capacity has proved itself to be the strongest explanatory independent variable. It alone account for 37 per cent variance in the marketed surplus of gram. Aggregate travel distance and tortuosity ratio are the other independent variables which are included in the model at 2nd and

**Table No 4.9**

**Correlation Coefficients (r) between Gram Arrival and Selected Transport Network Indices**

| *S. No.* | *Variables* | *r Values* |
|---|---|---|
| 1. | Direct Connectivity | —.223 |
| 2. | Tortuosity Ratio | —.014 |
| 3. | Aggregate Travel Distance | .586 |
| 4. | Local Degree (Road) | .372 |
| 5. | Local Degree (Rail) | .430 |
| 6. | Total Road Capacity | .607 |

3rd steps respectively. The explained variance for these three variables is .56, local degree for rail and direct connectivity are not included in the model because they do not contribute significantly towards $R^2$. The final regression equation* is given below.

In the equation, regression coefficient for total road capacity, aggregate travel distance and tortuosity ratio are significant at 1, 2, and 3 per cent level of significance. The comparison of increased $R^2$ by aggregate travel distance, tortuosity ratio and total road capacity shows the relative importance of these three contributors. Every additional mile increase in aggregate travel distance increases 14.5 quintals gram arrivals, and a unit increase in tortuosity ratio discourages gram arrival by 332972.27 quintals. This change is 20009.9 quintals in case of total road capacity.

* $Y = -332972.3 + 2009\ 96\ X_6 + 14.52\ X_5 - 332972.27\ X_2$

## Table No. 4.10

### Stepwise Regression Analysis of Gram Arrivals on Transport Network Nodality

| *Variable* | *Regression Coefficient* | *t* | *R* | *R2* | *Increase in R* | $\overline{R}$ | *F* | *S.E. of estimate* |
|---|---|---|---|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| **Step—1** | | | | | | | | |
| $X_6$ | 2423.108 | 4.323* | .607 | .369 | — | .607 | 18.690* | 35042.661 |
| **Step—2** | | | | | | | | |
| $X_6$ | 1741.581 | 3.104* | .707 | .499 | .131 | .695 | 15.452* | 31710.191 |
| $X_3$ | 17.383 | 2.842* | | | | | | |
| **Step—3** | | | | | | | | |
| $X_6$ | 2009.966 | 3.658* | | | | | | |
| $X_3$ | 14.524 | 2.428** | .749 | .561 | .062 | .730 | 12.794* | 30170.933 |
| $X_2$ | —332972 270 | —2.060*** | | | | | | |
| **Step—4** | | | | | | | | |
| $X_6$ | 1628 324 | 3 017* | | | | | | |
| $X_3$ | 14.316 | 2.336*** | .750 | .562 | .001 | .720 | 9.315* | 30650.431 |
| $X_2$ | —329114.996 | —1 996 | | | | | | |
| $X_5$ | 1064.282 | .262 | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Step—5** | | | | | | | | |
| $X_6$ | 2073.438 | 2.272*** | | | | | | |
| $X_3$ | 12.730 | 1.358 | | | | | | |
| $X_2$ | —319572.533 | —1.849 | .750 | .563 | .001 | .709 | 7.218** | 31164.434 |
| $X_5$ | 1132.304 | .274 | | | | | | |
| $X_1$ | —313.041 | —.226 | | | | | | |

* Significant at 1% level of significance
** Significant at 2% level of significance
*** Significant at 5% level of significance
**** Significant at 10% level of significance

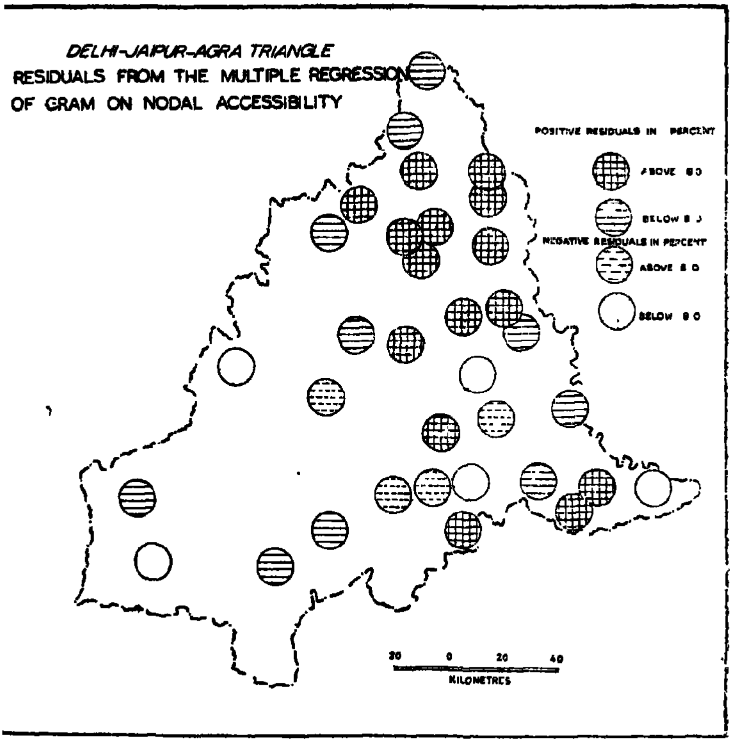

DELHI-JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE MULTIPLE REGRESSION
OF GRAM ON NODAL ACCESSIBILITY
POSITIVE RESIDUALS IN PERCENT
BELOW
NEGATIVE RESIDUALS IN PERCENT
ABOVE
BELOW
0 20 40
KILOMETRES

**Fig. : 4.8**

The multiple coefficient of correlation (R) between transportation network indices and marketed surplus of gram is 0.75 at the 3rd step. The coefficient of determination ($R^2$) is 0.56. Thus taken together can explain 56 per cent variation in gram arrivals. F test has been carried out to see the validity and significance of the multiple correlation. On the basis of calculated F value the multiple coefficient of correlation is significant at 1 per cent level of significance. The residuals from the multiple regression are plotted in Map No. 4.8.

**4.6.2 Residuals from the regression of marketed gram on mandi accessibility :**

The composite index of transport nodality explained around 20 per cent variance in the arrival of gram. The western and south-western part of the region is characterised by dry farming. All the mandis which lie much above the regression line are located here. Agra is the only exception, where very high positive results are due to large secondary arrivals. The mandis where positive and negative residuals are minimum, surround the Alwar district. Except Dausa, all those mandis where the actual gram arrivals are slightly less than the estimated value are located along Haryana, Rajasthan border. Most of the mandis starting from Delhi border to Achhnera in the eastern part along the Yamuna river have very high negative residuals where the gram arrivals are much below the predicted value (Map No. 4.9).

## SECTION—V

### 4.7 Marketed Surplus of Bajra and Transport Network Nodality

**4.7.1 Residuals from regression of marketed bajra on total road capacity :**

On the basis of significant regression* coefficient we can predict that every additional unit increase in total road capacity will increase 1451.9 quintals of marketed surplus of bajra.

* $Y = -11433.87 + 1451.90\,X$.

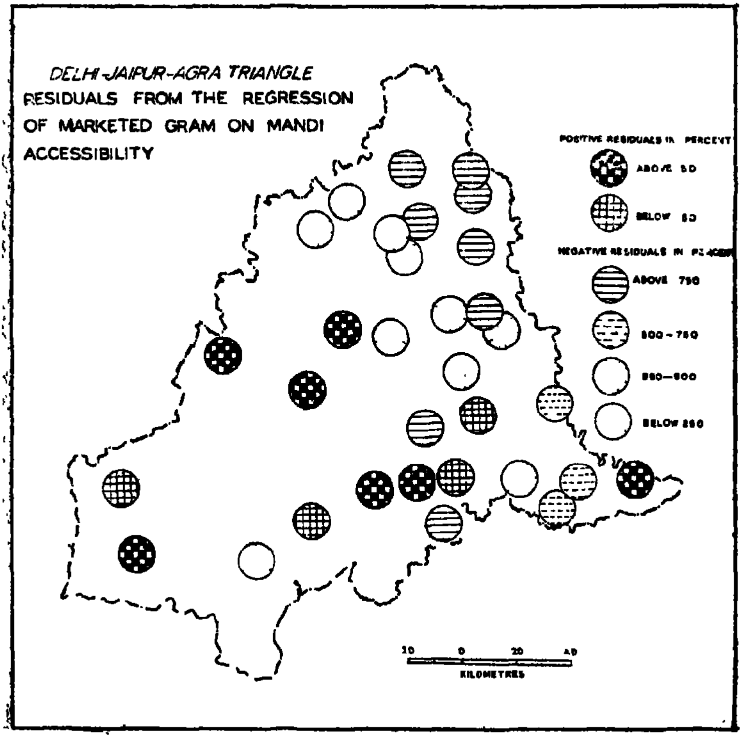

DELHI-JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE REGRESSION
OF MARKETED GRAM ON MANDI
ACCESSIBILITY
ABOVE 750
KILOMETRES

Fig. : 4.9

The coefficient of determination, $R^2$=.42, which means that the that road capacity can explain nearly 42 per cent variance in the marketed surplus of bajra in the mandis. But, there are large regional variations in the unexplained variance (which is 58 per cent) for this commodity. Achhnera, Punahana and Pataudi have highest positive residuals, more than 100 per cent. The mandis of the negative residuals are well marked in the eastern side because there is less production of bajra in this part of the region. Agra claims more than estimated bajra arrivals because it is a large regional and administrative centre where bajra comes from even beyond its notified area, some times from far distant areas. Chomu has sufficiently high negative deviations, Rewari and Kotputli have low negative residuals. The sparsely distributed mandis of west and south-west have very low and moderately positive residuals (Map No. 4.10), meaning thereby the arrival of bajra is more than what has been predicted with the help of total road capacity, as an explanatory variable.

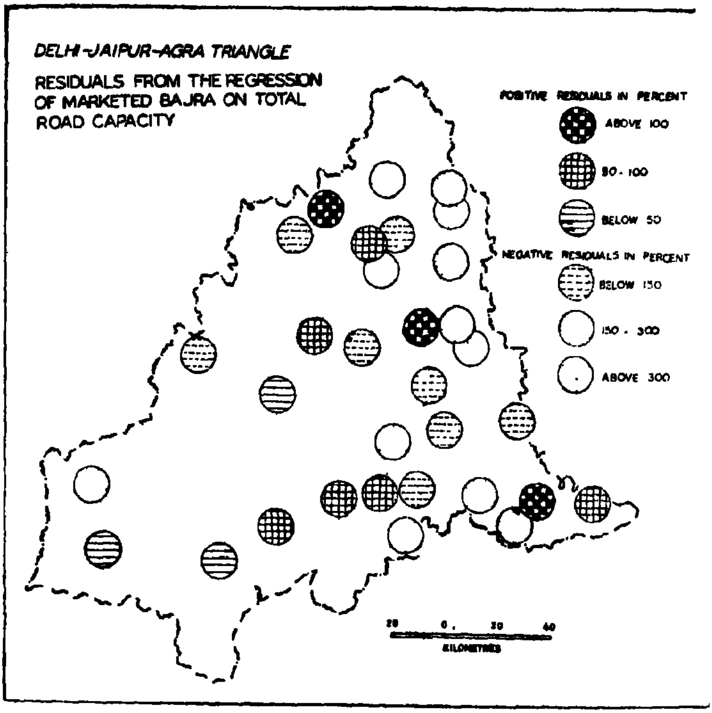

DELHI-JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE REGRESSION OF MARKETED BAJRA ON TOTAL ROAD CAPACITY
POSITIVE RESIDUALS IN PERCENT
ABOVE 100
50 - 100
BELOW 50
NEGATIVE RESIDUALS IN PERCENT
BELOW 150
150 - 300
ABOVE 300
20 0 20 40
KILOMETRES

Fig. : 4.10

**Table No. 4.11**

**Stepwise Regression Analysis of Bajra Arrivals on Transport Network Nodality**

| *Variable* | *Regression Coefficient* | *t* | *R* | *R2* | *Increase in R2* | $\overline{R}$ | *F* | *S.E. of estimate* |
|---|---|---|---|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| **Step—1** | | | | | | | | |
| $X_6$ | 1451.906 | 4.80.* | .647 | .419 | — | .647 | 23.059* | 18903.650 |
| **Step—2** | | | | | | | | |
| $X_6$ | 1099.664 | 3.595* | .727 | .529 | .110 | .717 | 17.416* | 17287.881 |
| $X_3$ | 8.984 | 2.695** | | | | | | |
| **Step—3** | | | | | | | | |
| $X_6$ | 889.785 | 2.573** | .743 | .553 | .024 | .724 | 12.357* | 17127.314 |
| $X_3$ | 8.340 | 2.495** | | | | | | |
| $X_5$ | 2844.281 | 1.259 | | | | | | |
| **Step—4** | | | | | | | | |
| $X_6$ | 1233.342 | 2.454*** | .752 | .566 | .013 | .723 | 9.457* | 17168.512 |
| $X_3$ | 4.639 | .900 | | | | | | |
| $X_5$ | 2948.985 | 1.301 | | | | | | |
| $X_1$ | —696.760 | —.944 | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Step—5** | | | | | | | | |
| $X_6$ | 1233.784 | 2.432* | | | | | | |
| $X_3$ | 4.787 | .919 | | | | | | |
| $X_5$ | 2786.614 | 1.211 | .757 | .573 | .007 | .717 | 7.517** | 17320.472 |
| $X_1$ | —569.690 | —.741 | | | | | | |
| $X_2$ | —65164.932 | —.678 | | | | | | |

* Significant at 1% level of significance
** Significant at 2% level of significance
*** Significant at 5% level of significance
**** Significant at 10% level of significance

### 4.7.2 Stepwise multiple regression analysis of transport indices and marketed surplus of bajra :

The marketed surplus of bajra has been regressed on 6 transport nodality variables.

Table No. 4.12

**Correlation Coefficient—(r) between bajra Soldout in the Mandis and Selected Transport Accessibility Variables**

| *Sl. No.* | *Variable* | *r Value* |
|---|---|---|
| 1. | Direct Connectivity | .011 |
| 2. | Tortuosity Ratio | —.096 |
| 3. | Aggregate Travel Distance | .577 |
| 4. | Local Degree (Road) | .340 |
| 5. | Local Degree (Rail) | .530 |
| 6. | Total Road Capacity | .647 |

Except direct connectivity and tortuosity ratio, the last 4 variables have significant association with the marketed surplus of bajra at different levels of significance. Among them, total road capacity has the closest association with the dependent variable (bajra arrivals). Like earlier excercises, total road capacity which has the maximum r value with the arrival size of bajra, has been taken in the Ist step of the regression, which alone explained 42 per cent variance. The next important contributor is the aggregate travel distance. This increased the $R^2$ by .110. In the third step, local degree (rail) has been added in the model, though it contributes marginally (only 2.4%). By these three variables collectively 55 per cent variance in the marketed surplus of bajra is explained. Direct connectivity local degree (road) and tortuosity ratio have been left out from the model because after third step, standard error of estimate starts rising and $\bar{R}$ declines. The final regression equation*

* $Y = -41263.76 + 889.78\, X_6 + 8.34 X_3 + 2844.28\, X_5$.

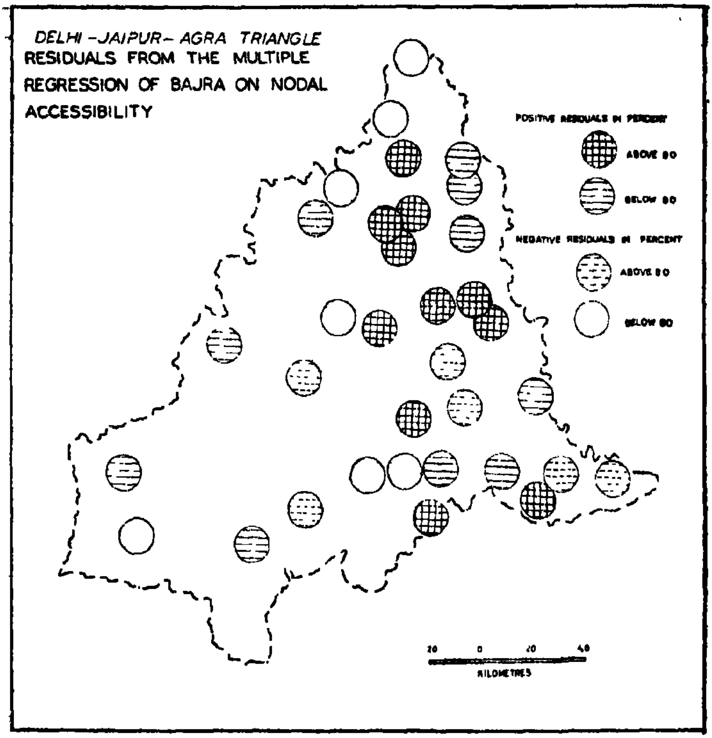

DELHI - JAIPUR - AGRA TRIANGLE
RESIDUALS FROM THE MULTIPLE
REGRESSION OF BAJRA ON NODAL
ACCESSIBILITY
NEGATIVE RESIDUALS IN PERCENT
20 0 20 40
KILOMETRES

Fig. : 4.11

shows that the total marketed surplus of bajra is sensitive to road capacity. Every additional unit increase in total road capacity causes a total increase of 889.8 quintals of bajra arrivals under the given situation. The regression coefficient of aggregate travel distance is also significant at 2 per cent level. The multiple correlation (R) for 1st three variables in the model is .74. The coefficient of determination ($R^2$) is .55 as shown in table No. 4.11. This means that more than 55 per cent of the variation in the bajra arrival may be explained by these three transport variables. The F test shows that the multiple coefficient of correlation is significant at 1 per cent level. The residuals from the multiple regression are plotted on Map No. 4.11.

**4.7.3 Residuals from the regression of marketed surplus of bajra on mandi accessibility :**

The composite index of transport network nodality explains around 30 per cent of the variations in the marketed surplus of bajra. Kotputli and Bhusawar are only two mandis where actual arrivals are even more than 100 per cent in relation to expected marketed surplus. All the mandis in between Aravalli range and Yamuna river have negative residuals of various magnitudes (Map No. 4.12). Agra is an exception due to its secondary arrivals. All the mandis in the western and south-western part have positive residuals with the exception of Chomu and Rewari, which have high negative residuals. There are 14 mandis where the relative residuals are more than 150 per cent. These are located in a north-south direction in the eastern part of the region.

## SECTION—VI

**4.8. Total Marketed Surplus and Transport Network Nodality :**

**4.8.1 Residuals from the regression of marketed surplus on total road capacity :**

Total road capacity as an explanatory variable accounts for 42 per cent variance in marketed surplus as denoted by the

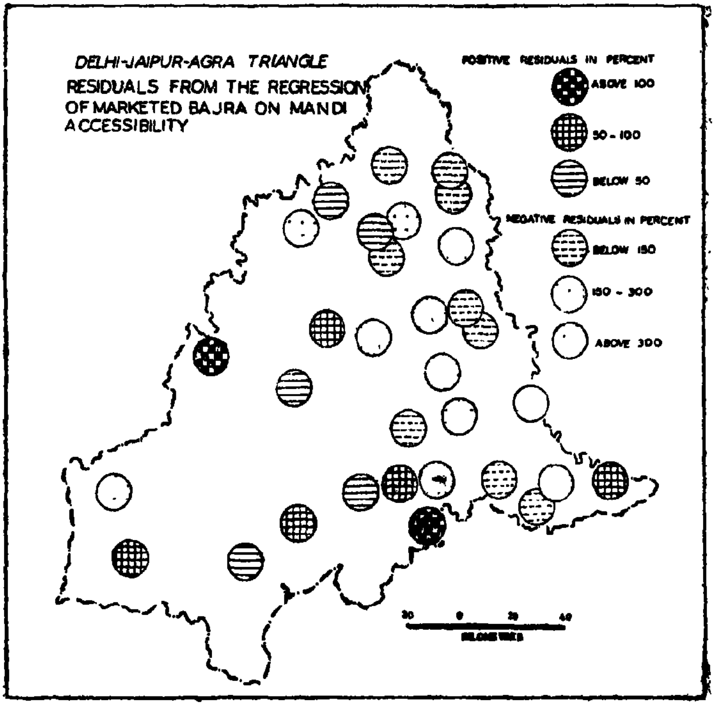

DELHI-JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE REGRESSION OF MARKETED BAJRA ON MANDI ACCESSIBILITY
POSITIVE RESIDUALS IN PERCENT
ABOVE 100
50 - 100
BELOW 50
NEGATIVE RESIDUALS IN PERCENT
BELOW 150
150 - 300
ABOVE 300

Fig. : 4.12

coefficient of determination ($R^2$) which is .42. Map No. 4.13 shows that the highest positive residuals are noted for Pataudi, Punahana and Achhnera mandi, which are located at far distances. These are the mandis where marketed surplus as predicted with the help of total road capacity of these mandi centres, is much less than the actual volume of the commodities marketed there. The main explanation is that these mandis have very low total road capacity hence a less amount of marketed surplus has been predicted which brings very high positive residuals on Map No. 4.13. Here the interference of other factors is in positive direction. Whereas there is a continuous belt of moderately high positive residuals extending from Tauru southwards upto the southern end of the region. From the physiographic point of view, the said area is characterised by barren land, the topography is uneven with least irrigation facilities and highly effected by flood havoc caused due to the breakage of dams in the rainy season. This part of the region has relatively poor transportation facilities. But the arrivals are more than the expected figures. Most of the mandis located in the well irrigated belt along the Yamuna river, receive, much less quantity of agricultural commodities than predicted, because of the high score of road capacities of these mandis. Punahana, Deeg, Achhnera and Agra are the exceptions to this. In case of Agra and Jaipur, huge secondary arrivals are recorded. The supply area is not restricted to notified areas only but it extends to far distances and that explains how the arrivals at Jaipur and Agra are more than prediction. In case of other mentioned mandis, the arrival prediction is much less due to low level of their total road capacity. The regulated mandis where there are highest negative deviations, are not located with some definite pattern. With a few exceptions, they are located on national highways indicating their high total road capacities, hence high prediction for market arrivals. Sohna and Nagar are the only exceptions. So far as total road capacity of Sohna is concerned, it is relatively low but at the same time the arrivals are relatively much less, hence we get higher negative residuals. Kotputli and Dausa are the only mandis characterised by moderately high negative deviations from the actual mandi arrivals. Though their total road capacity may

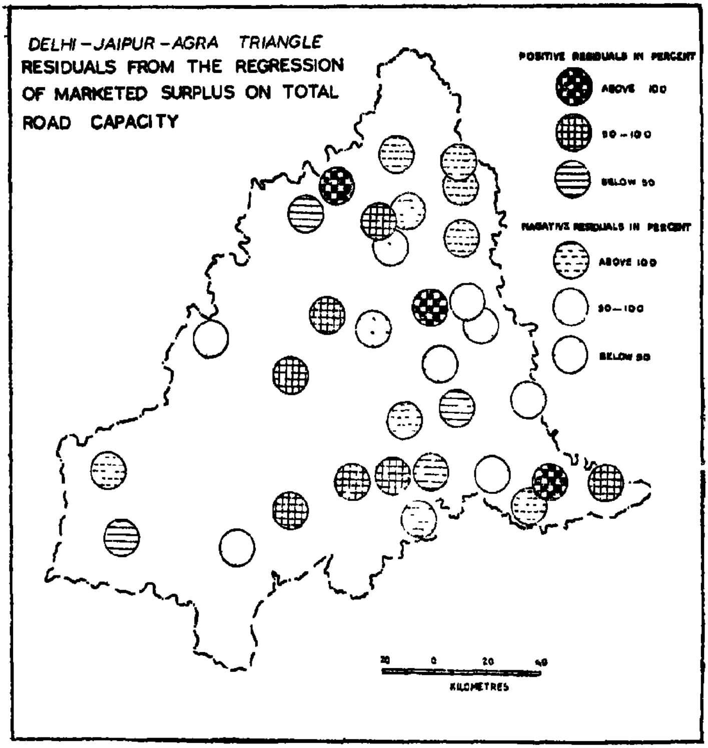

DELHI-JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE REGRESSION OF MARKETED SURPLUS ON TOTAL ROAD CAPACITY
POSITIVE RESIDUALS IN PERCENT
ABOVE 100
50-100
BELOW 50
NEGATIVE RESIDUALS IN PERCENT
ABOVE 100
50-100
BELOW 50
20 0 20 40
KILOMETRES

Fig. : 4.13

**Table No. 4.13**

**Stepwise Regression Analysis of Total Arrivals on Transport Network Nodality**

| *Variable* | *Regression Coefficient* | *t* | *R* | *R2* | *Increase in R2* | $\overline{R}$ | *F* | *S.E. of estimate* |
|---|---|---|---|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| **Step—1** | | | | | | | | |
| $X_6$ | 15334.038 | 4.798* | .647 | .418 | — | .647 | 23.018* | 199826.950 |
| **Step—2** | | | | | | | | |
| $X_6$ | 10588.422 | 2.936* | .712 | .507 | .088 | .701 | 15.914 | 186994.612 |
| $X_5$ | 57404.259 | 2.354** | | | | | | |
| **Step—3** | | | | | | | | |
| $X_6$ | 13166.462 | 3.363* | | | | | | |
| $X_5$ | 52284.535 | 2.265*** | .736 | .542 | .036 | .7159 | 11.840* | 183114.538 |
| $X_1$ | —7805.323 | —1.526 | | | | | | |
| **Srep—4** | | | | | | | | |
| $X_6$ | 13323.281 | 3.398* | | | | | | |
| $X_5$ | 51944.801 | 2.155*** | .746 | .557 | .015 | .7158 | 9.106* | 183246.113 |
| $X_1$ | —6113.721 | —1.131 | | | | | | |
| $X_2$ | —993302.810 | —.978 | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Step—5 | | | | | | | | |
| $X_6$ | 12533.311 | 2.297*** | | | | | | |
| $X_5$ | 51209.888 | 2.069*** | | | | | | |
| $X_1$ | —4804.573 | —.581 | .747 | .557 | .001 | .705 | 7.054** | 186340.134 |
| $X_2$ | —100249.085 | —.970 | | | | | | |
| $X_3$ | 11.883 | .212 | | | | | | |

* Significant at 1% level of significance
** Significant at 2% levol of significance
*** Significant at 5% level ef significance
**** Significant at 10% level of significance

be below average, and we do not expect higher surplus. But due to poor surroundings and low productivity, arrivals remain far below the expectations, which results in moderately high negative deviations. Jaipur, Rewari, Deeg and Nadbai have least but positive deviations and Nuh, Ferozepur Jhirka, Palwal, Hodel, Kosikalan, Kaman, Mathura and Bharatpur have minimum deviations from the actual arrivals towards negative side. These are the mandis where one observed the maximum explanation in mandi arrivals by total road capacity. For earlier mandis which do not make any contiguous belt, factors other than total road capacity keep positive effects, whereas for later mandis, some unexplained factors make their negative imprints.

**4.8.2 Stepwise multiple regression of the total agricultural marketed surplus and transport network accessibility variables :**

The dependent variable (Y) is the total of marketed surplus of wheat, sarson, gram, barley and bajra, in terms of quintals. The results of simple correlation are given in the following table :

**Table No. 4.14**

**Correlation coefficients (r) between marketed surplus and transport nodality indices**

| *S. No.* | *Variable* | *r Value* |
|---|---|---|
| 1. | Direct Connectivity | .108 |
| 2. | Tortuosity Ratio | —.109 |
| 3. | Aggregate Travel Distance | .458 |
| 4. | Local Degree (Road) | .481 |
| 5. | Local Degree (Rail) | .608 |
| 6. | Total Road Capacity | .647 |

The coefficient of correlations for the first two sets are insignificant. The total road capacity has the closest association with total marketed surplus. Instead of taking all the transport network indices initially to explain variations in total marketed surplus, it was thought proper to put one at a time in the regression model. In the first step, total road capacity has been taken, because it has highest correlation with dependent variable (total marketed surplus). The results of stepwise regression (Table No. 4.13) show that total road capacity explains the maximum variance in the total marketed surplus. In the second step, local degree rail has been included, as it is the second major contributor towards explained variation. These two variables can expain 51 per cent variation in the total arrivals. Direct connectivity which has been put in the model at the 3rd step could add 4 per cent towards explained variance. Tortuosity ratio which entered the exercise only at the 4th step could add marginally (1.5 per cent). Aggregate travel distance does not have significant contribution. The sixth variable, local degree road, has not been taken because of the multicolinearity problem. Local degree road and total road capacity are not independent statistically. Total road capacity includes the explanatory power of local degree road as well.

It is noted from table No. 4.13 that at every step, the standard error of the estimate of Y goes on reducing upto the 3rd step. This shows the growing accuracy of the predictive model. After 3rd step, the standard error of estimate begins to rise. R values continue to rise only upto 3rd step. It increase as tortuosity ratio and aggregate travel distance are included in the model. Which means that the contribution of these two variables in increasing the explained variation is not strong enough to counter-balance the reverse effect on the explanatory power of the model. Thus, the study of standard error of estimate of Y and $\bar{R}$ directs that the stepwise exercise should be terminated at the 3rd step. The value of F-ratio is significant in all the three steps. In the final regression equation* the agricultural marketed surplus has been regressed over the transport

*$Y = -49888.9 + 13166.5\, X_6 + 52284.5\, X_5 - 7805.3\, X_1$.

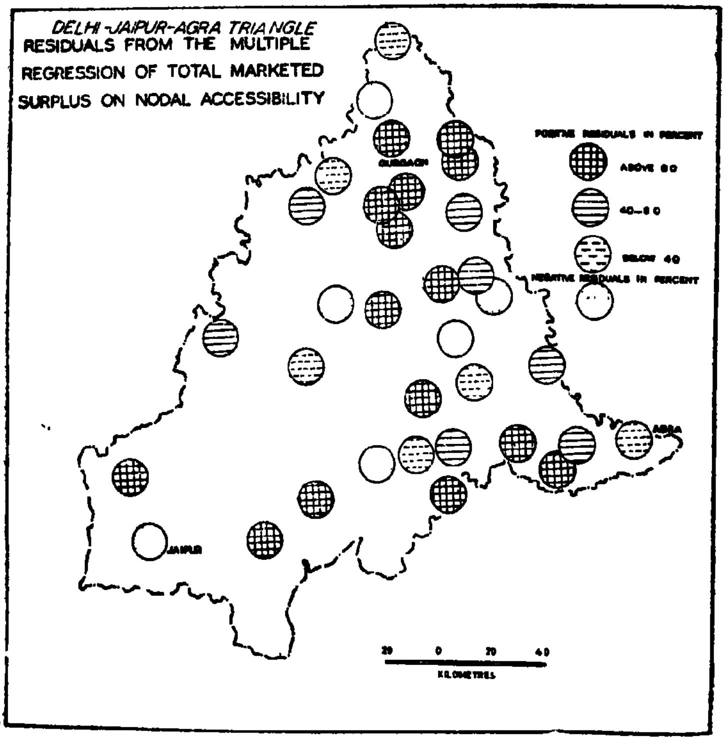

DELHI-JAIPUR-AGRA TRIANGLE
RESIDUALS FROM THE MULTIPLE
REGRESSION OF TOTAL MARKETED
SURPLUS ON NODAL ACCESSIBILITY

Fig. : 4.14

modality indices. This predicts the change in marketed surplus as a result of change in transport network status. The regression coefficients of local degree rail ($b_3$) and total road capacity ($b_4$) are significant at 2 and 1 per cent level of significance respectively. Meaning thereby that an additional unit of local degree rail increases 52284.5 quintals of total marketed surplus. In case of total road capacity, this change is 13166.5 quintals under similar conditions. The multiple coefficient of correlation is R=0.74 and the coefficient of determination $R^2$=0.54, which indicates that the 3 transport accessibility indicators when taken together can explain around 54 per cent variation in marketed surplus. The calculated value of F is 11.80 which is much higher than the value given in the F distribution table hence the relationship between transport network indices when taken together and marketed surplus is significant at 1 per cent level. Their association is not by chance but there is significant casual relationship between them.

As shown by $R^2$ at the 3rd step in the stepwise regression (table no. 4.13), the model could explain only 54 per cent variance in the total marketed surplus. 46 per cent of the unexplained variance is still left out, for which one has to search out some other independent explanatory variables. The relative residuals from the stepwise multiple regression of total marketed surplus are depicted in Map No. 4.14. Generally the positive residuals of highest magnitude are found longitudinally in the central part of the region. This belt is surrounded by negative residuals from three sides. Both the largest centres of the region (Jaipur and Agra) have negative residuals.

### 4.8.3 Regression of agricultural marketed surplus on mandi accessibility :

The coefficient of correlation (r) between marketed surplus (total of wheat, sarson, barley, gram and bajra) and

1. Mandi accessibility is the composite index of various indices of nodality as discussed on page number 26 Chapter number 2.

mandi accessibility is 0.64. The results of the regression* are given below.

The b value (regression coefficient) is significant at 10 per cent level of significance for 30 degrees of freedom. This indicates that one unit increase in transport network accessibility predicts an average increase in marketed surplus in the mandi which is equvalent to 12,129,4 quintals, in monetary terms in the given situation. Coefficient of determination ($R^2$) is 0.41, which means that the mandi accessibility can explain 41 per cent variance in the marketed surplus. For the remaining 59 per cent unexplained variance in the arrivals we have to search out some other explanatory variables. The magnitude of relative residuals [($Y_{obs}$-$Y_{est}$)÷Yobs]* shows the influence of forces other than accessibility on arrival size. These residuals show large regional disparities in Map No. 4.15. Apart from Agra, which is located extremely in south-eastern corner of the region, all other mandis which have positive residuals are located in the western half of the region. Which also means that this is the area (western part of the region) where we have mandi arrivals more than expectations, if seen in context of the transport network development of mandi points. This is because, being less developed from transport point of view, the prediction of surplus is less in the western region, where as the actual arrivals are much more due to large catchment areas of mandis. The mandis of western region have larger hinterlands because they are located at farther distances and are few in number. As a result they could collect relatively larger produces. But if the arrival data could have been divided by the mandi hinterland area of the respective mandis for all the mandis in the region the picture could have been entirely different. The arrival per unit of area would be less in western and south-western part of the region. Most of the mandis of district Mathura, Bharatpur southern Gurgaon and southern Faridabad have lowest but nagative residuals, which indicates

* $Y = a + bx = -346339 + 121294\,x$.

* Where $Y_{obs}$ is the observed value and $Y_{est}$ is the predicted or estimated from the equation.

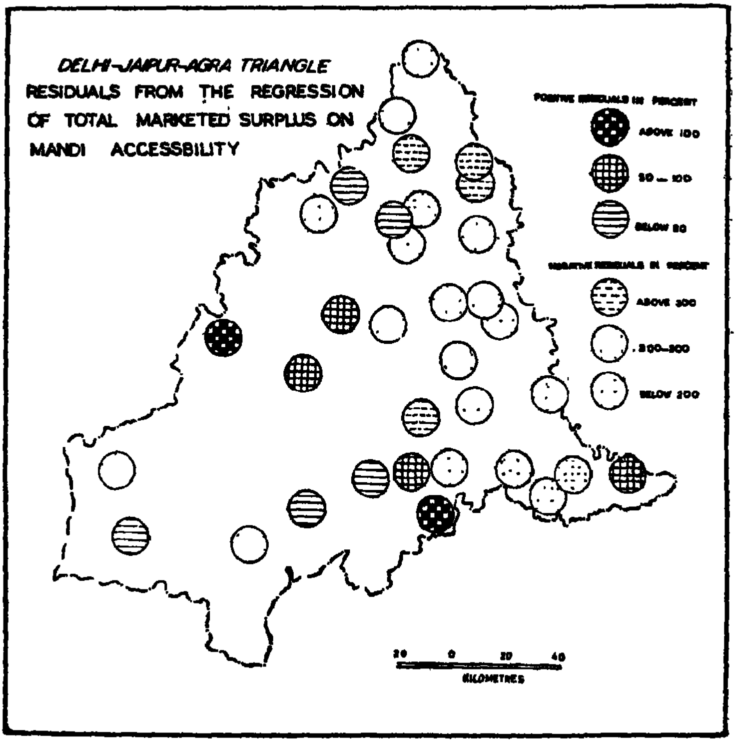

DELHI–JAIPUR–AGRA TRIANGLE
RESIDUALS FROM THE REGRESSION
OF TOTAL MARKETED SURPLUS ON
MANDI ACCESSBILITY
ABOVE 100
ABOVE 300
200–300
BELOW 200
20 0 20 40
KILOMETRES

Fig. : 4.15

that the estimated marketed surplus in the context of accessibility is more than the actual marketed surplus. Gurgaon, Faridabad, Ballabgarh and Nagar have marketed surplus much less than the prediction. Gurgaon, Ballabgarh and Faridabad are the prominent industrial centres and also administrative centres. Both the activities require high transport accessibility. Even more, because of their location over national highway, they have high connectivity but emerge poor from marketed surplus point of view, when judged in relation to accessibility. Since these mandi towns have very high score for transport network accessibility, they are expected to receive very high arrivals. There are large differentials between actual and estimated arrivals. Sohna, Achhnera and Fatehepur Sikri have moderately high negative relative residuals. There seems to be two clear cut divisions in the patterns of residuals over the map (fig. 4.15). In the eastern side, is the agricultural marketed surplus below the prediction whereas over Aravalli and over its western side, the marketed surplus is more than the estimated. The western and south-western part of the region which is covered by unproductive surface, the collecting points (mandis) of agricultural produce are located relatively at high distance. Thus larger catchment areas are witnessed for these mandi towns. Even then, their arrivals are below prediction. It is because these mandi towns being administrative centres, have to possess certain level of transport accessibility to meet the administrative and other socio-economic demands, irrespective of what and how much is being brought to these places from their hinterlands. There are large variations in the unexplained variance in the marketed surplus. In order to explain this remaining variance, two things should be done. The marketed surplus values should be made relative by dividing the area of their respective mandis. Secondly, the mandis which receive large secondary arrivals (particularly Agra and Jaipur), should be dropped from the analysis. Only then the relative residuals should be plotted on the maps. The explanations for the remaining variance in marketed surplus may be found by comparing these maps with the maps of corresponding area showing intensity of irrigation, some index of ruggedness, index of mechanization and soil fertility. Some of these factors might

explain the corresponding residuals upto great extent. In the eastern side of the region extending from Delhi to Bharatpur, the influence of the factors other than transport is in negative direction, whereas the influence in western half of the region is positive. The mandis which fall under third and fourth category have closest relationship or least fluctuations in the actual marketed surplus and marketed surplus as predicted with the help of mandi accessibility index.

**4.9 Conclusion :**

The coefficient of correlation (as shown in table no. 4.1) shows that among all the indices of transport network structure in Set I, the cyclomatic number has closest association with the arrival of sarson and total of all the commodities marketed, which is significant at 1 per cent level. The remaining variables of connectivity from this set have poor association with the arrivals of different commodities in the mandis. The variables in set I, i.e., cyclomatic number, alpha, gama, beta, eta and theta, represent the efficiency of transport network of mandi hinterlands. These indices, indeed, speak of interconnectedness vertices of through the edges. Here in this context it is not that important to the farmer how efficiently his village is linked to other villages in the mandi hinterlands. The more important is how efficiently his village is linked to the mandi centre. If more villages of the mandi hinterland are linked straight to the mandi centre by roads, it well encourage more arrivals by reducing transport cost of the produce which he takes to the mandi.

On the other hand, the indices of nodal accessibility (as shown in set II in table 4.1) have very strong association [illegible] the size of arrival of various commodities. The compo[illegible] index of mandi accessibility, and its indices individually have statistically very strong and significant relat[illegible]hips with the arrival size of various commodities. The [illegible] indicates that among all the variables of mandi [illegible] total road capacity has closest association with the arri[illegible]ze of various commodities. Leaving apart sarson, its (total road

capacity) relation with arrival of all other commodities is significant at 99 per cent confidence level. Excluding direct connectivity and tortuosity ratio, all other variables of accessibility are correlated with the arrival size at various significance levels. The relationship between mandi arrivals on one hand, direct connectivity and tortuosity ratio on the other hand is not significant even at 90 per cent confidence level. Strong associations between arrival size of commodities and high score of accessibility supports the hypothesis that if the capacity of the mandi points, which of course, depends upon how efficiently a mandi town is linked to other towns and commercial centres to dispose of the arrival size is efficient and quick, more arrivals will be encouraged.

Total road capacity alone could explain 34 per cent variance in the wheat arrivals. Total road capacity, aggregate travel distance and local degree (rail) could explain 46.4 per cent variations in the marketed wheat surplus. Among different transport network variables, local degree (rail) is the most important variable to explain the variations in the barley arrivals in different mandis. It explains 32 per cent variations. If total road capacity and tortuosity ratio are included in the regression model, their explanatory capacity increases to 48 per cent.

For marketed surplus of sarson also local degree (rail) is the most important explanatory variable. But it could hardly explain 22 per cent variation in sarson arrivals. The other independent variables which could be included in the regression model are aggregate travel distance, tortuosity ratio and total road capacity. Thus, at the fourth step of stepwise regression, these four variables account for 36 per cent variations in total marketed surplus of sarson.

Total road capacity is the strongest single most important explanatory variable for gram arrivals in the mandis, which accounted for 37 per cent variance. Aggregate travel distance and tortuosity ratio are the other two explanatory variables which were included in the regression model and could explain 56 per cent variance.

In case of bajra also, the total road capacity is the strongest variable to account for the variations in its arrivals. It explained 42 per cent of the variance. Aggregate travel distance and local degree (rail) are included in the model at 2nd and 3rd steps and collectively explained 55 per cent variance in the marketed surplus of bajra.

The total road capacity explains the maximum variance (42 per cent) in the total marketed surplus (addition of wheat, barley, sarson, gram and bajra), 54 per cent variance is explained by taking two more variables in explanatory model, i.e. local degree (rail) and direct connectivity.

Residuals from the regression of agricultural marketed surplus on transport nodel accessibility variables, show large regional disparities.

5

# Spatial Pattern of Mandi Arrivals—A Case Study of Five Mandis

## 5.1 Introduction :

In this section, an attempt has been made to understand the agricultural marketing patterns of five selected regulated mandis (i.e., Gurgaon, Sohna, Nuh, Hodel and Punahana) and 650 villages. The main objective of this village level study is to test the following inter-relationship of mandi hinterlands as tested by Neal et. al.[1]

(i) How far different mandis have circular-shaped hinterlands. Whether they are comparable with notified and hypothetical hinterlands.

(ii) Theoretically, the pattern fromed by the agricultural marketing intensity is generally circular in shape. How far it stands true in case of Delhi-Jaipur-Agra Triangle.[2] What fac-

1. W.L. Neal, H.S. Mavi and J.P. Singh, "Kurali Market : A Report on the Economic Geography of Marketing in North Punjab", *Economic Development and Cultural Change*, Vol. 13, no. 2, (19 5), pp. 129-68.
2. Th s villa e level study has been conducted only for five mandis of Punahana, Hodel, Nuh, Sohna and Gurgaon, which covers a contiguous area in the central part of the triangle

factors distort the concentric zones of agricultural marketing intensities.

(a) The zone of maximum intensity should occupy nearest position to the mandi centre. It varies inversely with the distance.

(b) The sellers of agricultural produce reduce in number as we go away from the mandi. Also the frequency of the arrival declines with the distance.

(c) Thirdly, from the nearby villages, even the smallest surplus quantity of agricultural produce which a farmer wishes to sell can be transported economically with any mode of transportation. Whereas, from the distant villages, it is not economical to bring very small produce to the mandi yard. Thus as the distance from the mandi increases, it receives less produce but it is transported in bigger quantities.

(iii) There is obviously a positive relationship between land productivity and agricultural marketing. But the natural hinderances in the transport of agricultural produce like river or hill etc. may restrict the quantity of arrivals in the mandis.

(iv) Better road accessibility would increase the intensity of total arrivals. In other words, the villages located along the roads, which lead towards the mandis, assure more arrival, the farmers bring their produce frequently and the average size of commodities is larger.

In order to test the above points, five mandis have been selected. For this purpose, a continuous area around Gurgaon, Hodel, Nuh, Sohna and Punahana mandis has been selected because an isolated mandi cannot show the real pattern of the farmer's agriculture marketing who come to a mandi from different villages. If a single or an isolated mandi is taken the village located at the margin of the mandi area, cannot represent the real picture. Because there is possibility that

these marginal villages might be taking some of their produce to other nearby mandis also. At the same time, it is not possible to take all the mandis of the triangle and collect village wise data for their agricultural products. Keeping in view the above considerations the present study was conducted,

**5.2 Nature of data, fieldwork and Methodology :**

For this study, the data has been collected from the mandi headquarters at Nuh, Sohna, Punahana, Hodel and Gurgaon for the year 1975-76 (April 1, 1975 to March 31, 1976). The nature of the data collected, includes the quantity of agricultural produce for different commodities brought to the mandi by each farmer, the village address of the farmer who sold his produce at mandi yard, and the rate at which it was purchased by different purchasing agencies. This information is recorded from the Auction Register of the respective market committees. The information was precured for 124 villages of Gurgaon mandi area, 114 villages of Sohna, 127 of Hodel, 152 of Nuh and 133 villages of Punahana mandi area.

Village-wise marketed-surplus has been tabulated for all the major commodities, with the help of choropleth maps, commodity-wise mandi hinterlands have been delimited and the zones of agricultural marketing intensity identified. Pearson's coefficient of correlation has been calculated to test the hypothesis that with the increase in distance from the mandi, the arrival of agricultural produce and its frequency declines. The distance from the mandi has been taken as the independent variable (X), the arrivals of different agricultural commodities and the number of arrivals have been denoted by 'Y' (as the dependent variables). For the sake of convenience, correlation matrices have been prepared for the above mentioned variables for each mandi separately. Regression lines have been calculated and plotted for the number of arrivals of agricultural produce (Y) and the distance from the mandi (X). The diagrams show that the relationship between distance from the mandi (X) and frequency of arrivals (Y) is curvilinear. It has been made linear by replacing X with log 'X'. Thus the

equation for the regression line is $Y=a+b \log x$. This exercise has been done for the above stated five mandis individually and collectively as well. In order to observe the impact of road accessibility, an exercise in regression analysis has been done for the villages on the roads and villages which are away from the roads, separately. For this purpose, the villages have been selected from the respective mandi hinterlands in such a way that all sizes of villages and the entire sample area is represented.

In order to discuss further the agricultural marketing patterns, the hinterlands of the above five mandis were divided in four concentric zones each of 5 km. radius from the mandis upto a distance of 20 kms. The fifth outer most belt includes all those villages which are located beyond 20 kms. from the grain market. With the help of these concentric zones and five major agricultural commodities, (i.e., wheat, barley, sarson, gram and bajra), the hypothesis that with the increase in distance the arrival size declines, was put to a rigorous test.

## 5.3 Mandi-wise Analysis :

### 5.3.1 Gurgaon Mandi :

Gurgaon mandi is located very near to the southern border of Delhi. Apart from wheat, barley and sarson are the only products of some importance which are brought to the mandi for sale. Most of the barley, wheat and sarson comes from the western and south-western side. On the basis of attached Maps No. 5.1 one cannot conclude anything about the concentric zones of marketing intensity or the relationship between distance and the arrival of commodities. The arrival of barley per hundred acres decreasesas we go away from the mandi centre, as shown by highly significant r value ($r=-.35$). The distance from the mandi has highly significant negative relationship with total frequency of all commodities and barley, individually.

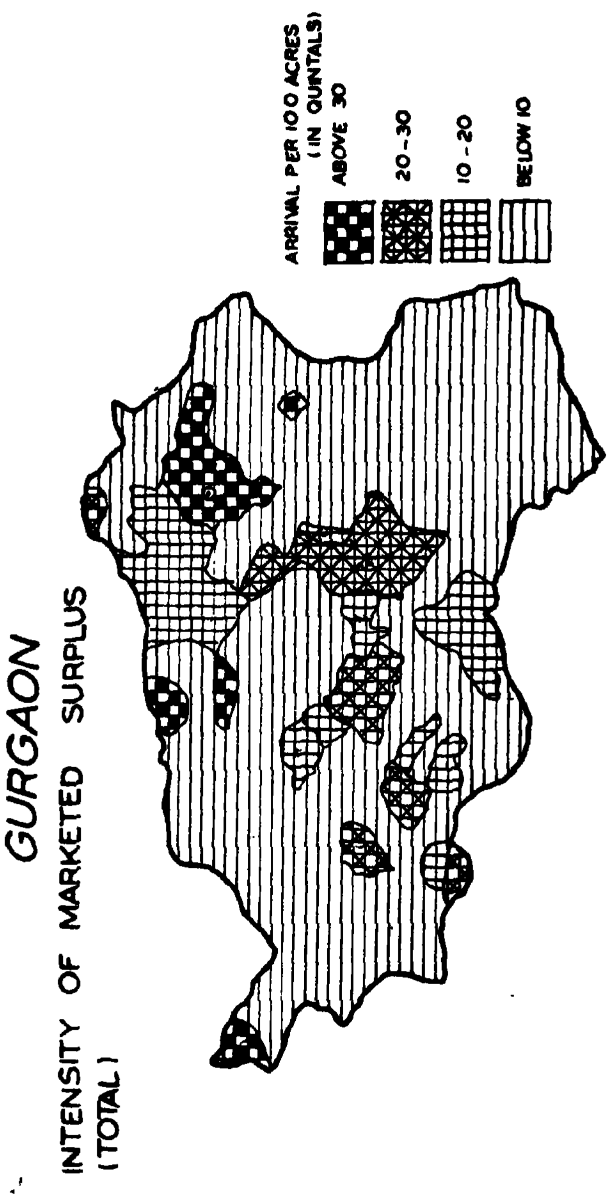

GURGAON
INTENSITY OF MARKETED SURPLUS
(TOTAL)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 30
20 – 30
10 – 20
BELOW 10

Fig. : 5.1 (A)

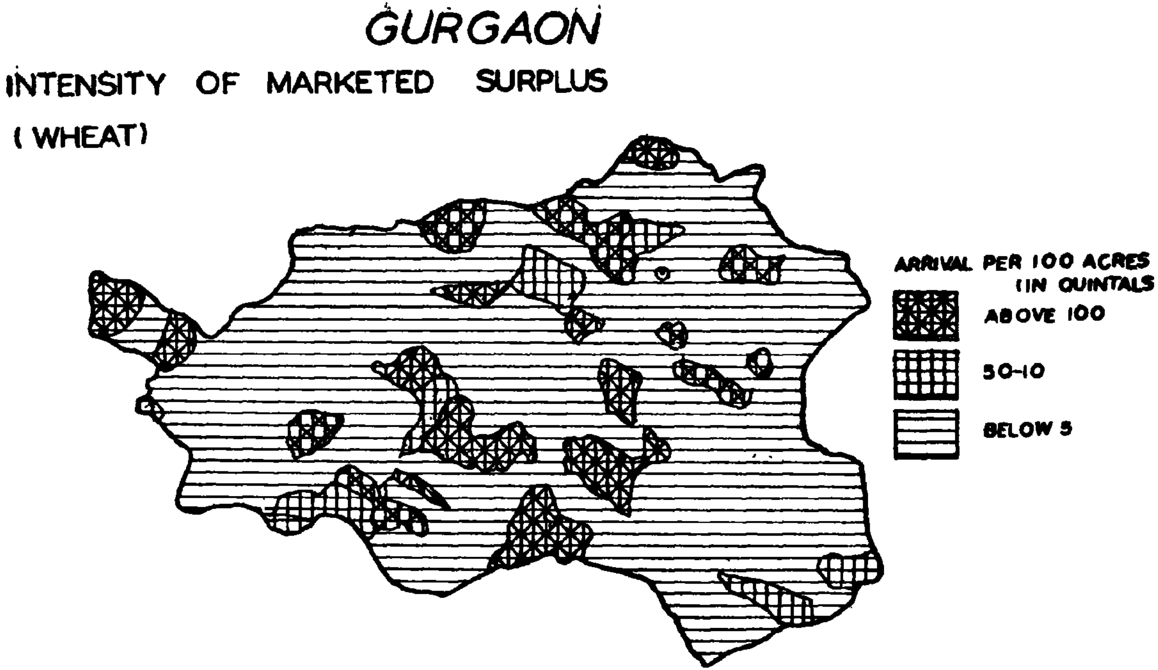

GURGAON
INTENSITY OF MARKETED SURPLUS
( WHEAT)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 100
50-10
BELOW 5

Fig. 5.1 (B)

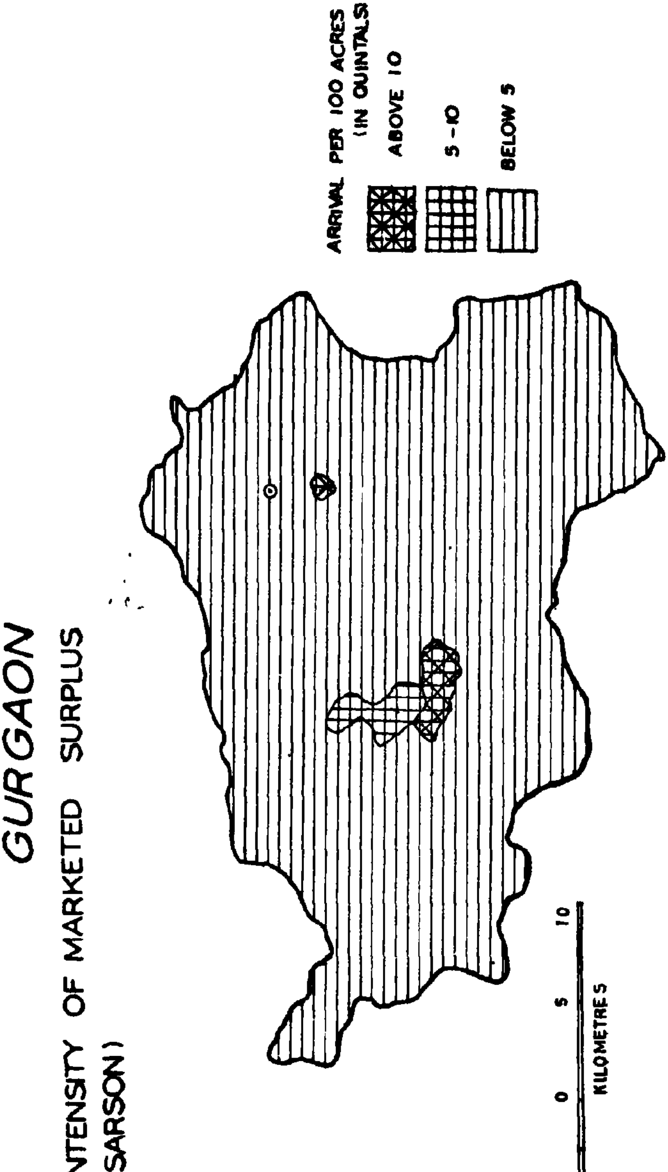

GURGAON
INTENSITY OF MARKETED SURPLUS (SARSON)
ARRIVAL PER 100 ACRES (IN QUINTALS)
ABOVE 10
5 -10
BELOW 5
5 0 5 10
KILOMETRES

Fig. : 5.1 (C)

GURGAON

INTENSITY OF MARKETED SURPLUS (BARLEY)

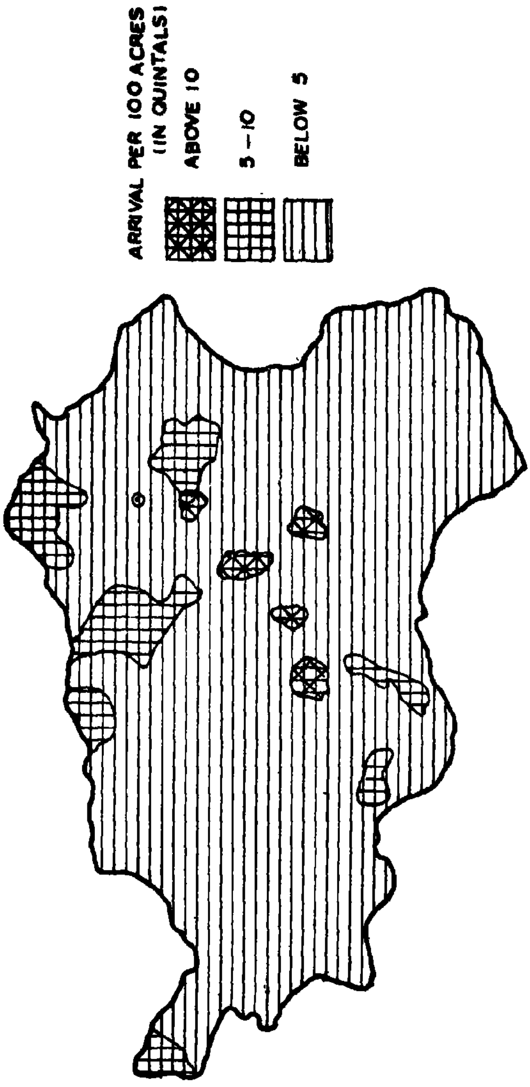



Fig. : 5.1 (D)

The regression equation for the distance from the mandi (logX) and the frequency of arrivals of all the commodities is given in the following foot note. Though the regression line in sloping downwards from left to right (Fig. no. 5.2) with low gradient, the 'r' value is only —.22.

The arrival pattern of the major agricultural commodities at Gurgaon mandi centre shows large deviations from the hypothesis that with the increasing distance the arrival size declines. The villages located in the inner most zone of 5 kms. radius from the market centre contribute only 13.29 per cent of the mandi's total wheat. Whereas the next outer zone of 5 to 10 kms. adds another 7.13 per cent. Thus all the villages located in the radius of 10 kms. contribute only 20.42 per cent of the total wheat marketed at Gurgaon mandi yard. Whereas the next two outer zones together account for more than 30 per cent wheat. Almost half of the mandi's total wheat is brought to the mandi yard from the villages which have the distances of more than 20 kms. from the market. Wheat arrivals per village do not decline consistently with the increasing distance from Gurgaon mandi. Surprinsingly, the highest arrival per village is from those villages which are located at the distance of 15 to 20 kms. from the market centre. The second inner most zone which extends from 5 to 10 kms. records only 49 quintals of wheat per village, which is the lowest record. The villages which are more than 20 kms. away, bring as high as 107 quintals per village. Anyhow, in case of barley, the maximum quantity (29.76 per cent) comes from the villages of nearby zone. This percentage went down to 14.28 per cent in the second distance zone of 5 to 10 kms., rises to 24.34 per cent in the third zone and reduces to 14.06 per cent in the distance zone of 15 to 20 kms. Lastly, the villages located more than 20 kms. away from the market, accounted for 17.56 per cent of the total barley marketed there. The maximum average arrival of barley per village is not from the inner-most zone. Rather it is the third distance zone (10 to 15 kms.) which records the maximum quantity of barley (average being

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$Y = 58.10 - 25.92 \log X$.

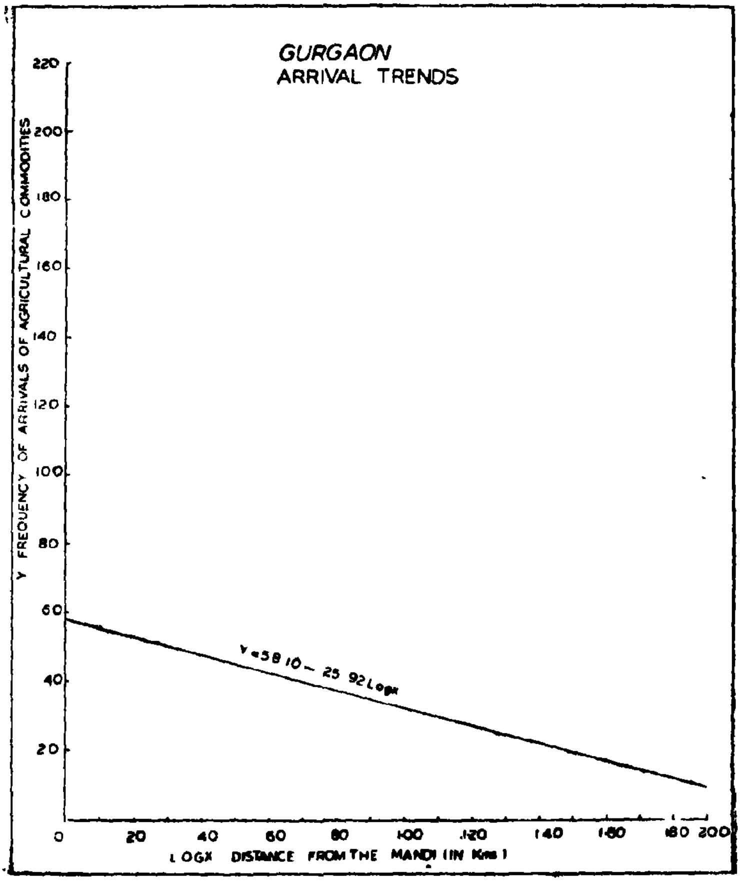

GURGAON
ARRIVAL TRENDS
Y FREQUENCY OF ARRIVALS OF AGRICULTURAL COMMODITIES
220
200
180
160
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
160
180
200
LOGX DISTANCE FROM THE MANDI (IN Kms)

Fig. : 5.2

40 quintals per village). The average marketed surplus from villages located within 5 kms. distance is 34 quintals. The next outer zone of 5 to 10 kms. brings only 20 quintals of barley per village. Its average arrival is 29 quintals and 17 quintals from 4th and 5th zones, respectively.

**Table No. 5.1 (a)**

**Wheat Quantity Received as Percentage to Total**

| *Distance from the Mandi* | *Sohna* | *Gurgaon* | *Hodel* | *Punahana* | *Nuh* |
|---|---|---|---|---|---|
| Less than 5 kms. | 25.17 | 13.29 | 34.72 | 29.29 | 10.51 |
| 5–10 kms. | 47.82 | 7.13 | 46.03 | 47.06 | 25.67 |
| 10–15 kms. | 15.34 | 17.40 | 5.24 | 17.03 | 30.22 |
| 15–20 kms. | 6.30 | 13.05 | 5.55 | 5.17 | 25.62 |
| More than 20 kms. | 5.38 | 49.23 | 1.46 | 2.45 | 7.98 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table No. 5.1 (b)**

**Wheat Arrival Intensity*-(in Qtls.)**

| *Distance from the Mandi* | *Sohna* | *Gurgaon* | *Hodel* | *Punahana* | *Nuh* |
|---|---|---|---|---|---|
| Less than 5 kms. | 72 | 118 | 593 | 86 | 27 |
| 5–10 kms. | 79 | 49 | 393 | 92 | 35 |
| 10–15 kms. | 44 | 114 | 58 | 55 | 38 |
| 15–20 kms. | 28 | 135 | 61 | 42 | 51 |
| More than 20 kms. | 15 | 107 | 57 | 24 | 24 |

*Arrival intensity has been calculated by dividing the total quantity of the marketed surplus of a crop by the number of villages in that distance zone.

Table No. 5.2 (a)

**Barley—Quantity Received as Percentage to Total**

| *Distance from the Mandi* | *Sohna* | *Gurgaon* | *Hodel* | *Punahana* | *Nuh* |
|---|---|---|---|---|---|
| Less than 5 kms. | 33.65 | 29.76 | 24.91 | 38.47 | 10.44 |
| 5.—10. kms. | 41.59 | 14.28 | 30.77 | 44.35 | 27.20 |
| 10—15 kms. | 13.94 | 24.34 | 21.99 | 10.75 | 28.30 |
| 15—20 kms. | 6.73 | 14.06 | 8.27 | 1.52 | 24.60 |
| More than 20 kms. | 4.10 | 17.56 | 14.05 | 4.91 | 9.46 |

Table No. 5.2 (b)

**Barley-Arrival Intensity (in qts.)**

| *Distance from the Mandi* | *Sohna* | *Gurgaon* | *Hodel* | *Punahana* | *Nuh* |
|---|---|---|---|---|---|
| Less than 5 kms. | 385 | 34 | 1151 | 154 | 90 |
| 5—10 kms. | 247 | 20 | 569 | 102 | 113 |
| 10—15 kms. | 131 | 40 | 387 | 48 | 117 |
| 15—20 kms. | 108 | 29 | 218 | 21 | 77 |
| More than 20 kms. | 35 | 17 | 153 | 48 | 58 |

Table No. 5.3 (a)

**Sarson-Quantity Received as Percentage to Total**

| *Distance from the Mandi* | *Sohna* | *Gurgaon* | *Hodel* | *Punahana* | *Nuh* |
|---|---|---|---|---|---|
| Less than 5 kms. | 40.30 | 22.66 | 21.93 | 30.96 | 17.30 |
| 5—10 kms. | 36.22 | 9.84 | 24.65 | 49.38 | 29.29 |
| 10—15 kms. | 10.67 | 41.12 | 17.36 | 13.56 | 21.36 |
| 15—20 kms. | 7.65 | 15.43 | 6.06 | 1.99 | 16.14 |
| More than 20 kms | 5.16 | 10.96 | 30.00 | 4.12 | 15.91 |

Table No. 5.3 (b)

Sarson-Arrival Intensity (in qtls.)

| *Distance from the Mandi* | *Sohna* | *Gurgaon* | *Hodel* | *Punahna* | *Nuh* |
|---|---|---|---|---|---|
| Less than 5 kms. | 137 | 43 | 332 | 139 | 217 |
| 5—10 kms. | 59 | 21 | 160 | 141 | 196 |
| 10—15 kms. | 43 | 70 | 148 | 71 | 148 |
| 15—20 kms. | 38 | 48 | 52 | 21 | 99 |
| More than 20 kms. | 19 | 19 | 110 | 65 | 114 |

Table No. 5.4 (a)

Gram-Quantity Received as Percentage to Total

| *Distance from the Mandi* | *Sohna* | *Gurgaon* | *Hodel (Mator)* | *Punahana* | *Nuh* |
|---|---|---|---|---|---|
| Less than 5 kms. | 26.35 | 43.53 | — | 28.55 | 15.11 |
| 5—10 kms. | 24.32 | 0.00 | — | 40.56 | 24.61 |
| 10—15 kms. | 29.04 | 24.12 | — | 23.99 | 26.97 |
| 15—20 kms. | 15.54 | 10.59 | — | 2.61 | 19.52 |
| More than 20 kms. | 4.73 | 21.76 | — | 4.29 | 13.79 |

Table No. 5.4 (b)

Gram-Arrival Intensity (in qtls.)

| *Distance from the Mandi* | *Sohna* | *Gurgaon* | *Hodel (Mator).* | *Punahana* | *Nuh* |
|---|---|---|---|---|---|
| Less than 5 kms. | 17 | 37 | — | 42 | 59 |
| 5—10 kms. | 12 | — | — | 42 | 58 |
| 10—15 kms. | 22 | 8 | — | 50 | 64 |
| 15—20 kms. | 12 | 6 | — | 13 | 35 |
| More than 20 kms. | 7 | 5 | — | 27 | 41 |

**Table No. 5.5 (a)**

**Bajra-Quantity Received as Percentage to Total**

| *Distance from the Mandi* | *Sohna* | *Gurgaon* | *Hodel* | *Punahana* | *Nuh* |
|---|---|---|---|---|---|
| Less than 5 kms. | 45.99 | 28.44 | — | 46.76 | 27.48 |
| 5—10 kms. | 36.62 | 16.44 | — | 45.15 | 31.44 |
| 10—15 kms. | 8.37 | 18·96 | — | 6.72 | 20.42 |
| 15—20 kms. | 4.90 | 12.59 | — | 0.15 | 17.57 |
| More than 20 kms. | 4.12 | 23.56 | — | 1.21 | 3.09 |

**Table No. 5.5 (b)**

**Bajra-Arrival Intensity (in qtls.)**

| *Distance from the Mandi* | *Sohna* | *Gurgaon* | *Hodel* | *Punahana* | *Nuh* |
|---|---|---|---|---|---|
| Less than 5 kms. | 100 | 17 | — | 42 | 20 |
| 5—10 kms. | 47 | 22 | — | 32 | 21 |
| 10—15 kms. | 24 | 21 | — | 10 | 24 |
| 15—20 kms. | 23 | 12 | — | 3 | 13 |
| More than 20 kms. | 15 | 16 | — | 8 | 6 |

In case of sarson, a 10 kms. radius zone provides near about 32 per cent of the total quantity marketed at Gurgaon (Table No. 5.3 (a)), whereas the villages located within the distance range of 10 to 20 kms., record more than 56 per cent of the total sarson marketed there. Only 11 per cent is received from the villages which are beyond 20 kms. The arrival per village is the highest (70 quintals) from the third zone of 10 to 15 kms. range (Table 5.3 (b)). The average arrival per village is 43 quintals from the inner-most zone, 21 quintals from 2nd zone and 19 quintals from the outer-most zone.

43.53 per cent of the total marketed gram is received from a distance of 5 kms. from the mandi. 24.12, 10.59 and

21.76 per cent of the total gram is received from third, fourth and fifth zones respectively. In general, the arrival of gram per village is low. It is 37 quintals, from the inner-most zone, which is very high in comparison to the other zones. The outer three zones which cover the circular distance beyond 10 kms. have gram arrival below 8 quintals per village.

The arrival pattern of bajra cannot be generalized. 28.44 per cent bajra comes from the inner most zone. It declines to 16.44 per cent in the second inner most zone, again rises by more than 2 per cent in the third zone. The fourth zone of 15 to 20 kms. records 12.59 per cent and the outer-most villages (20 kms. away from the mandi) account for 23.56 per cent of the total marketed bajra.

We do not see large variations in the average arrival size of bajra per village in different concentric zones. The maximum is 22 quintals per village from the second zone and minimum is 16 quintals per village from more than 20 kms. away from the market centre.

The structure of the two inner most distance zones is almost identical. In both the rings, wheat is the first and the major contributor to the total marketed surplus. Proportionate share of barley in both the zones ranges from 18 to 19 per cent. The proportion of gram is negligible. The proportion of sarson and bajra ranges from 12 to 15 per cent and 6 to 9 per cent respectively. In the third zone the proportion of wheat is very high (60.93 per cent of the total marketed surplus within the zone). Sarson and barley together account for 34 per cent, bajra 3.61 per cent and gram only 1.16 per cent to the total. Beyond third zone, the proportionate share of wheat has shown a sharp rising trend. In the fourth concentric zone, wheat accounts for 71.39 per cent of the total marketed surplus. In the outer most zone, which includes the villages which are located beyond 20 kms, the contribution of wheat to the zone's total marketed surplus is as high as 89.41 per cent.

**Table No. 5.6**

**Gurgaon-Proportion of Different Crops in Different Distance Zones**

| *Distance from the Mandi* | *Wheat* | *Barley* | *Sarson* | *Gram* | *Bajra* |
|---|---|---|---|---|---|
| Less than 5 kms. | 57.20 | 18.84 | 14.75 | 2.56 | 6.65 |
| 5—10 kms. | 61.40 | 18.09 | 12.82 | 0.00 | 7.69 |
| 10—15 kms. | 60.93 | 12.54 | 21.77 | 1.16 | 3.61 |
| 15—20 kms. | 71.39 | 11.31 | 12.76 | 0.79 | 3.74 |
| More than 20 kms. | 89.41 | 4.70 | 3.02 | 0.54 | 2.33 |

### 5.3.2 Hodel Mandi :

Wheat and barley are the most important products of the mandi hinterland, brought to the yard. It is observed that the villages of Chhata tehsil, adjacent to Hodel, irrespective of distance, take their produce to Kosi Kalan. A salient feature of Hodel mandi hinterland is that it has larger command area in the north, north-west and west, whereas towards the north-east, the interaction is restricted due to river Yamuna. Here also the mandi catchment area makes roughly half circle (⌂) Pattern (Fig. No. 5.3). Inter-mandi hinterland interactions are frequent, meaning thereby, that the farmers of other mandi areas also bring their products to this mandi yard.

The commodity arrival patterns do not show perfect concentric circular zones. Anyhow, the villages which contribute highest (above 25 quintals per hundred acres) are located nearest to the mandi centre (Map No. 5.3) and the villages which record lowest arrivals (below 5 quintals per hundred acres) are mostly scattered towards north-west. The patches of medium arrivals are seen in the elongated shape from south-west to north-east. Statistically, there is negative relationship between total arrival of all commodities per hundred acres

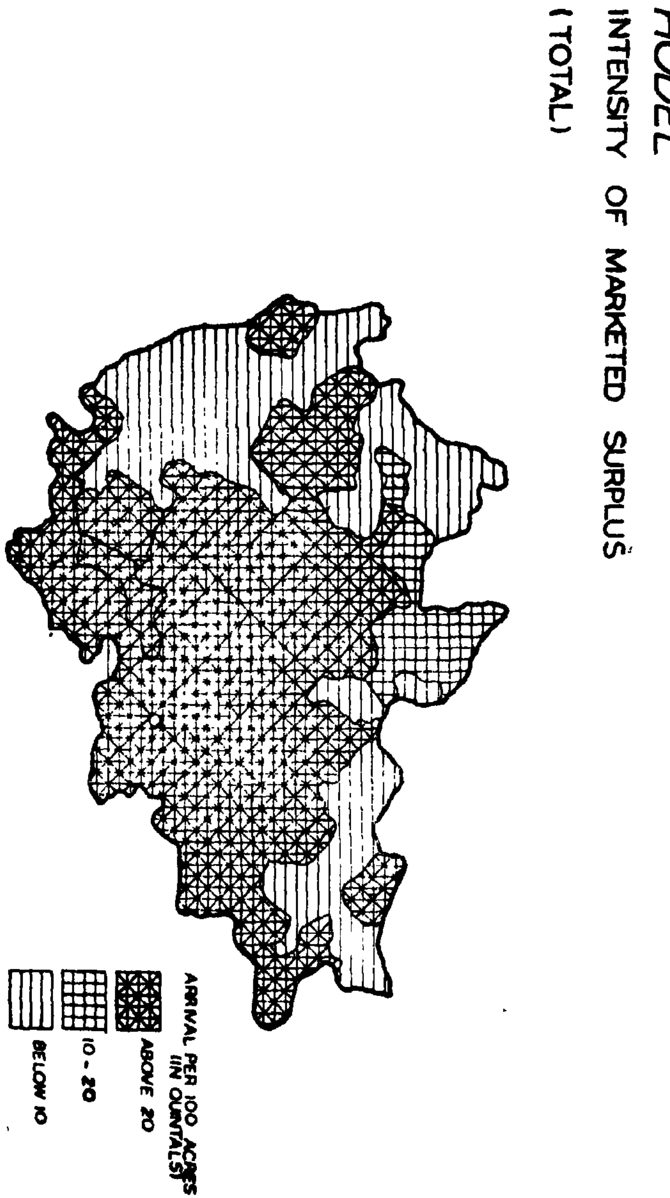

HODEL
INTENSITY OF MARKETED SURPLUS
( TOTAL )
ARRIVAL PER 100 ACRES (IN QUINTALS)
ABOVE 20
10 - 20
BELOW 10

Fig : 5.3 (a)

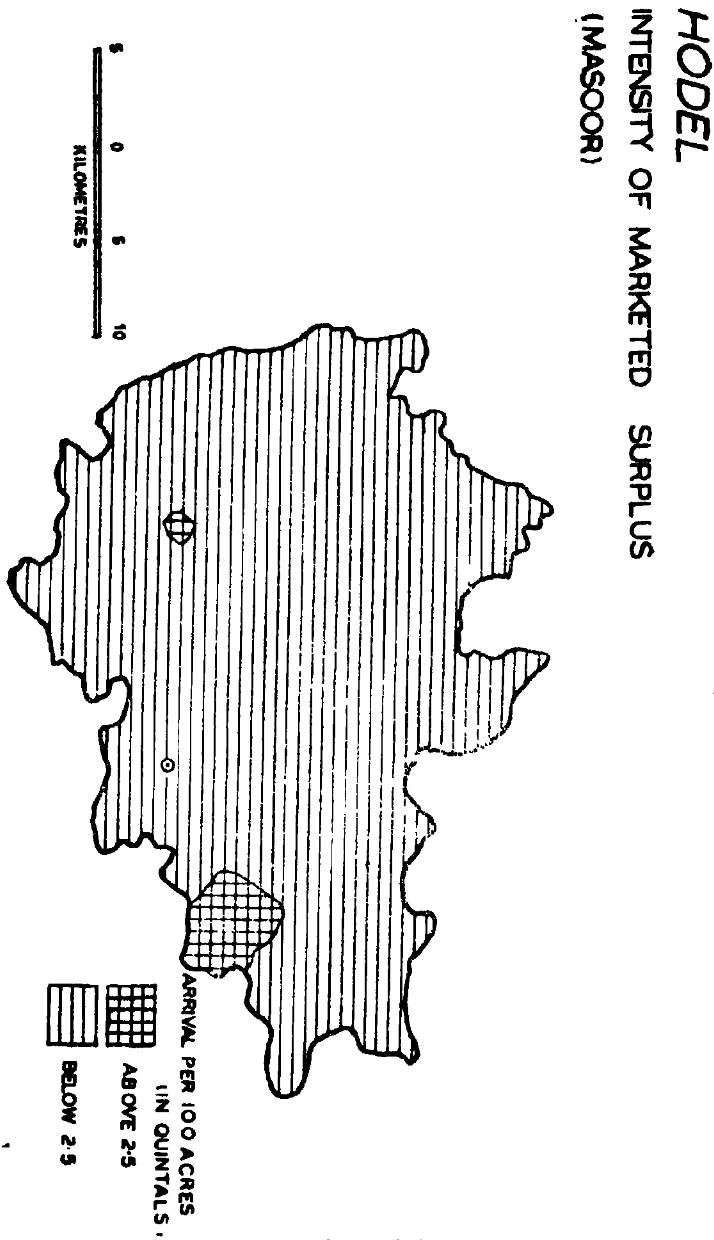

HODEL
INTENSITY OF MARKETED SURPLUS
(MASOOR)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 2·5
BELOW 2·5
5 0 5 10
KILOMETRES

Fig. : 5 3 (b)

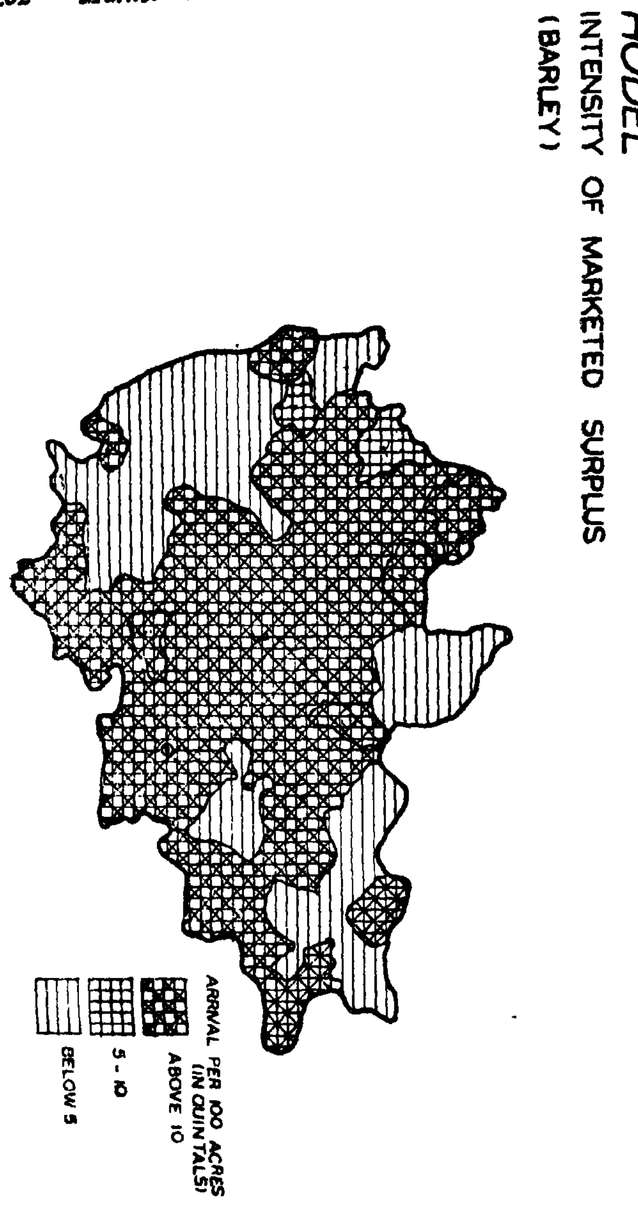

HODEL
INTENSITY OF MARKETED SURPLUS
(BARLEY)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 10
5 - 10
BELOW 5

Fig. : 5.3 (c)

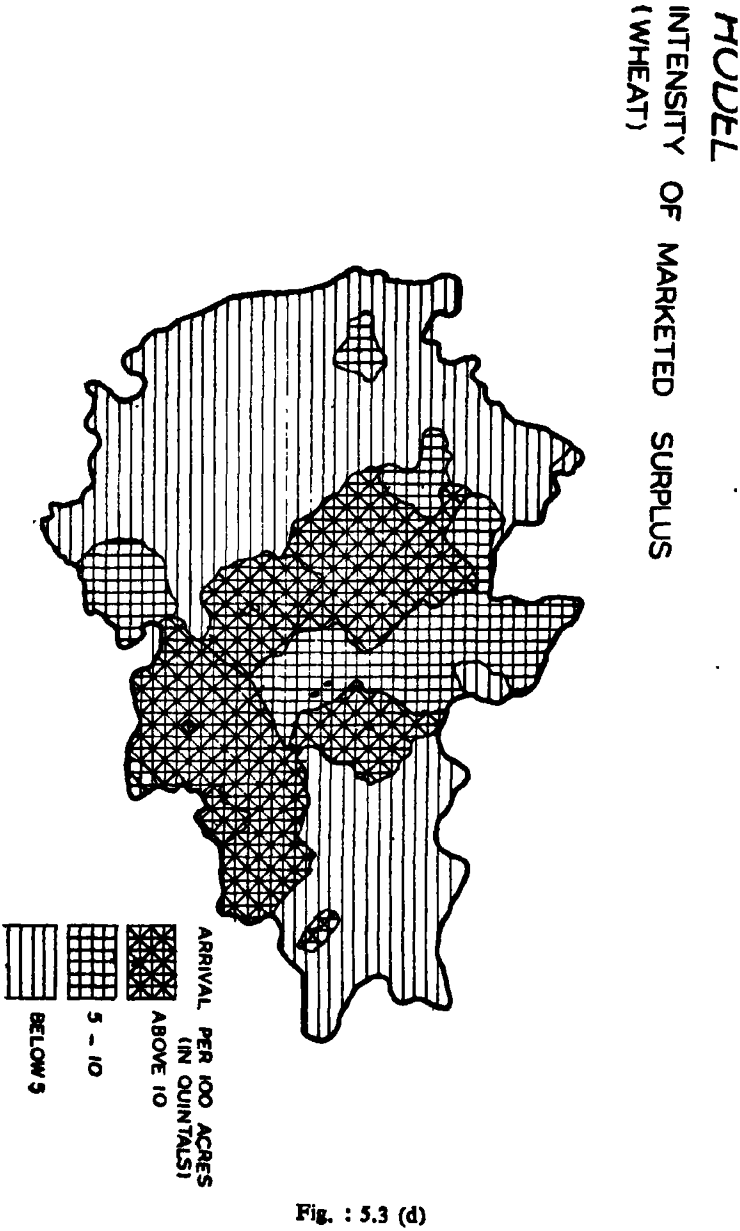

INTENSITY OF MARKETED SURPLUS
(WHEAT)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 10
5 – 10
BELOW 5

Fig. : 5.3 (d)

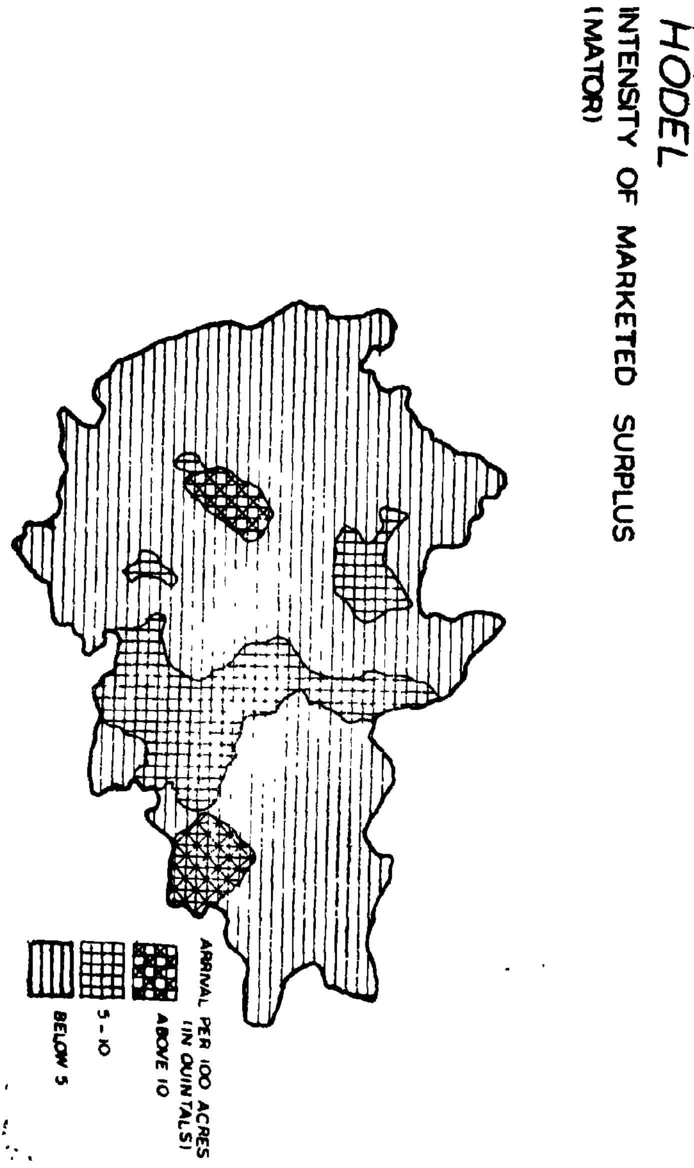

HODEL
INTENSITY OF MARKETED SURPLUS
(MATOR)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 10
5 - 10
BELOW 5

Fig. : 5 3 (e)

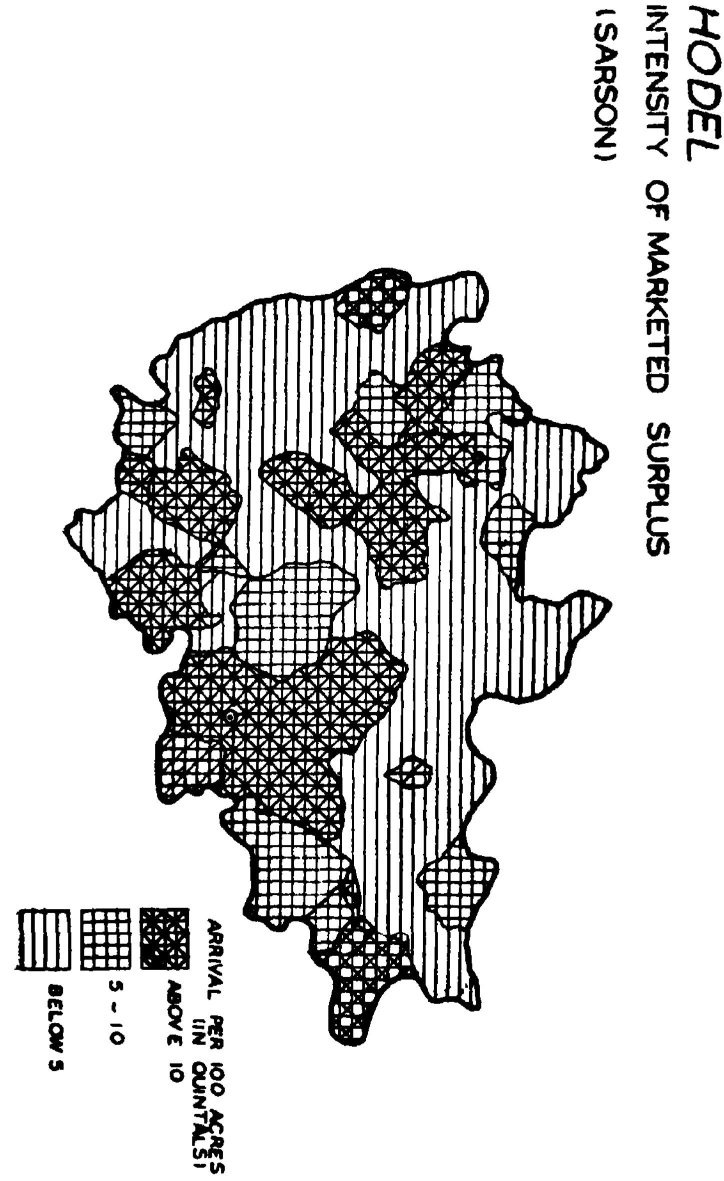

HODEL
INTENSITY OF MARKETED SURPLUS
(SARSON)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 10
5 - 10
BELOW 5

Fig. : 5.3 (f)

and distance of the villages from where the agricultural products are being brought. Here the distance factor (X) and frequency of all products (Y), while taken together, have shown highly significant but negative coefficient of correlation, (r=—.43). As we go away from mandi point, the farmers bring their products less frequently but in larger size. Its coefficient of correlation is .27, which is highly significant. Hodel is the only mandi which does not show significant relationship between absolute arrival size of various commodities and distance from the mandi (barley being the exceptional commodity). Whereas the distance factor has clear cut negative association if we take arrivals in relative terms. In case of all commodities collectively and separately, the relationship with distance from the mandi is negative and highly significant. The coefficient of correlation of distance from Hodel mandi with total arrival per hundred acres of all commodities, with wheat, sarson, mator, masoor, gur and barley are —.30, —.29, —.34, —.33, —.30, —.31 and —.43 respectively. All these values are highly significant. The 'r' values of distance factor and frequency of arrivals are —.43, —.34, —.39, —.41, —.35, —.36, and —.42 respectively. These are also highly significant at one level of significance. Thus the hypothesis that the arrival per hundred acres and the frequency of arrival of different agricultural products decline with the increase in distance from a mandi stand true.

While understanding the nature of relationship between distance from the mandi centre and frequency of arrivals, we get curvilinear form of the best fit line for different observations in the scattered diagram. The distance from the mandi centre (X) has been transformed to log X to get the regression* equation. The coefficient of correlation between distance from Hodel mandi (log X) and the frequency of arrivals of all commodities is —.59, and coefficient of determination is 0.35 as against 0.18 for distance from the mandi without log. There are some 10 villages in the mandi hinterland where the actual frequency of arrivals is much higher than the prediction (Fig. 5.4).

*$Y = 405.25 - 261.26 \log X$.

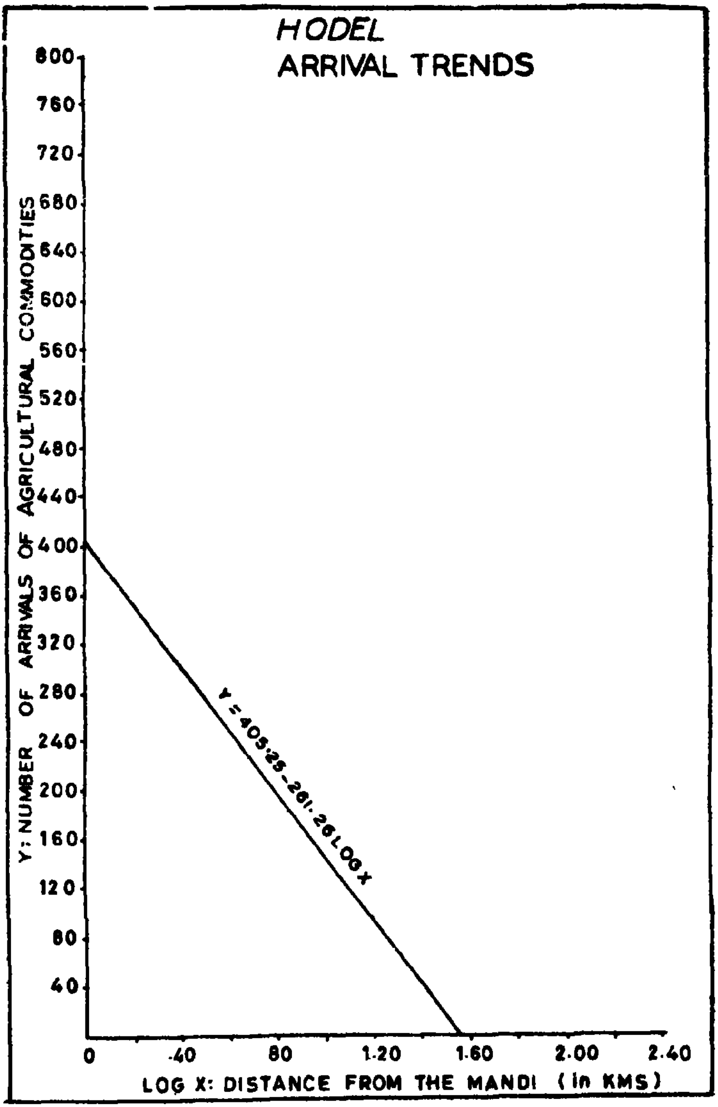

HODEL
ARRIVAL TRENDS
Y: NUMBER OF ARRIVALS OF AGRICULTURAL COMMODITIES
800
760
720
680
640
600
560
520
480
440
400
360
320
280
240
200
160
120
80
40
Y = 405.25 - 261.26 LOG X
0
.40
80
1.20
1.60
2.00
2.40
LOG X: DISTANCE FROM THE MANDI (in KMS)

Fig. : 5.4

Apart from the distance factor, the impact of transport routes is also superimposed. At Hodel, four major routes converge. High road density in the mandi hinterland also accelerates arrivals. The zone of highest arrival is tapering of along Hodel-Nuh and Hodel-Punahana routes. But one could not see this impact along the national highway, north and south of Hodel. It is because in the north, Palwal is one of the most important mandis which is in competition. Southwards, political boundary and competition from a nearby mandi is a disappointing feature (Fig. 5.3). There is a close association between distance from the mandi (log X) and frequency of arrivals for the villages which are away from the roads ($r = -0.60$) as compared to those villages which are on the roads where the association is insignificant, ($r = -0.07$).

Villages located within a distance of 5-10 kms. accounts for highest proportion of wheat (46.03 per cent) marketed at Hodel mandi yard. The total contribution of all the villages located within a radius of 10 kms. is 80.75 per cent. Villages which are more than 20 kms. away from the mandi, bring only 8.46 per cent of mandi's total wheat. Third and fourth zones account for 10.79 per cent of the total wheat marketed in this wholesale grain market.

Leaving apart the third concentric zone (10 to 15 kms. away from the mandi point), average arrival of wheat per village has shown declining trend with the increase of distance from the mandi yard. Its arrival per village is very high for the villages which are located within the distance of 5 kms. (i.e. 593 quintals per settlement). For the second zone, this quantity is 393 quintals, which is also very high. Beyond 10 kms., we notice an abrupt decline of 58 quintals per village. Beyond 10 kms., the inter zone variations are not much.

In case of barley, the second inner zone contributes 30.77 per cent (maximum) marketed there. Villages located within a distance of 5 kms. account for 24.91 per cent. The villages of third, fourth and fifth zones bring 21.99, 8.27 and 14.05 per cent of the total wheat marketed here.

The arrival per village has shown very clearly a declining trend from 1151 quintals for the villages which are within the radius of 5 kms. to 153 quintals for those villages which are beyond 20 kms. from the mandi.

The spatial arrival pattern of sarson is quite different. The villages located far away (beyond 20 kms.) contribute maximum (30 per cent) to the total marketed sarson. Second and first zones occupy second and third positions respectively. The arrival of sarson per village declines upto the distance of 20 kms. beyond which it shows an increase.

**Table No. 5.7**

**Hodel-Proportion of Different Crops in Different Distance Zones**

| *Distance from the Mandi* | *Wheat* | *Barley* | *Sarson* | *Gram* | *Bajra* | *Mator* |
|---|---|---|---|---|---|---|
| Less than 5 kms. | 29.42 | 50.73 | 16.46 | — | — | 3.38 |
| 5—10 kms. | 30.91 | 49.66 | 14.66 | — | — | 4.76 |
| 10—15 kms. | 6.40 | 64.50 | 18.77 | — | — | 10.33 |
| 15—20 kms. | 16.71 | 59.78 | 16.16 | — | — | 7.34 |
| More than 20 kms. | 11.48 | 45.84 | 36 08 | — | — | 6.60 |

If one analyses the proportionate share of each crop, zone wise, one finds that within a distance of 5 kms., half of the total marketed surplus is that of barley. Wheat accounts only for 29.42 per cent and sarson 16.46 per cent. In the second zone, total marketed surplus is composed of 49.66 per cent barley, 30.91 per cent wheat, 14.66 per cent sarson and 4.76 per cent mator. The arrival composition of the third zone is 6.40 per cent wheat, 64.50 per cent barley, 18.77 per cent sarson and 10.33 per cent mator. From this zone, the proportion of barley declines to 59.78 per cent in the fourth zone and 45.84 per cent in the outer most zone as shown in table No. 5.7

### 5.3.3 Nuh Mandi :

Nuh regulated mandi is located in the eastern foothills of Aravalli hills. Because of its location, it hardly receives any amount of commodity from western side of Aravalli, which serve as natural barrier. In the northern side of Nuh, Sohna mandi is located which comes in its competition. Hence limited area comes under its command. Most of the command area of this mandi is in the east and south. Mandi area does not make circular pattern for any of the major commodities brought in the mandi for sale. The principle of decreasing outward intensity of marketed surplus is not clear in the western side of the mandi, whereas in the eastern and southern part of Nuh mandi-area, one can observe (Fig. No. 5.5) clearly that the marketing intensity of agricultural produce declines as one goes away from the mandi. This hypothesis has been tested, statistically, by calculating coefficient of correlations between the distance from the mandi and arrival per hundred acres. The hypothesis stands valid only when the total of all commodities sold in the mandi is taken into account and not for individual commodities. In other words, there is a significant and negative relationship between distance from the mandi and total arrival of all commodities as denoted by r (—.23). With none of the commodities this relationship is significant on individual basis. Surprisingly, the relationship between distance from the mandi and frequency of each commodity has shown highly significant negative association for most of the commodities. Like other mandis, the farmers of the distant catchment area of Nuh bring their produce less frequently but in large volumes whereas the villagers from less distance bring their products even in very small quantity and more frequently. The regression equation* which has been calculated for the distance from mandi (log X) and the frequency of arrivals (Y) for Nuh mandi indicates a negative association. The 'r' value is only —.36 and the coefficient of determination is only .13. Even after reducing the X variable into log X, one fails to get the accurate linear pattern for the scattered dotes. The regression line drawn in figure No. 5.6 could not make the nature of relationship very clear.

* $Y = 135.71 - 77.06 \log X$.

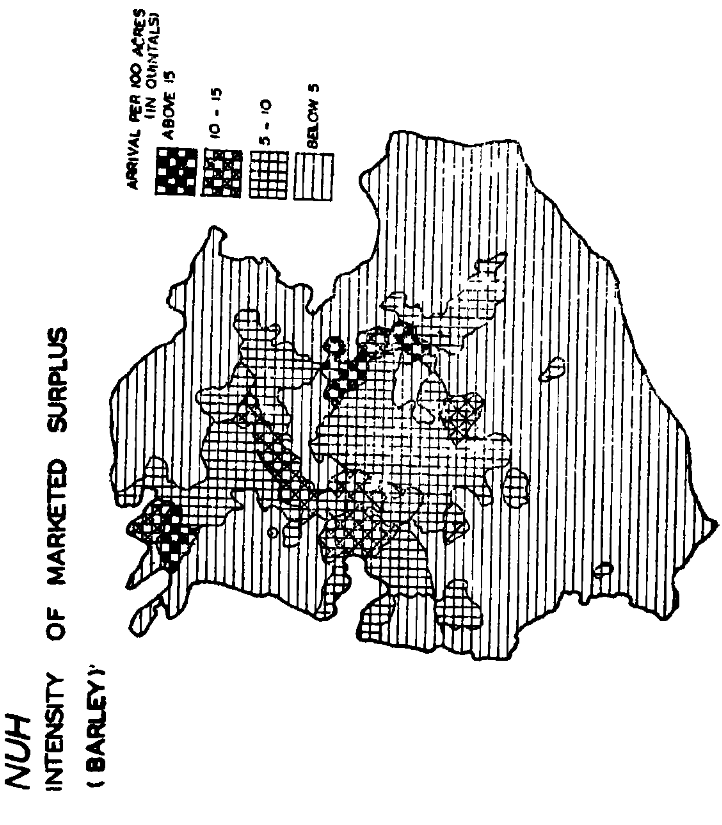

NUH
INTENSITY OF MARKETED SURPLUS
( BARLEY )
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 15
10 - 15
5 - 10
BELOW 5

Fig. 5.5 (a)

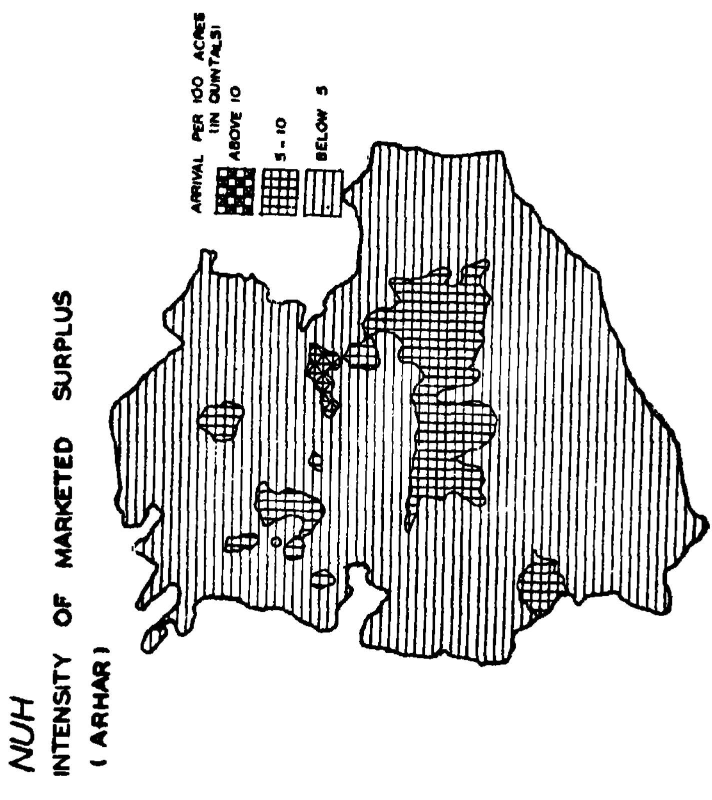

NUH
INTENSITY OF MARKETED SURPLUS
( ARHAR )
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 10
5 - 10
BELOW 5

Fig. 5.5 (b)

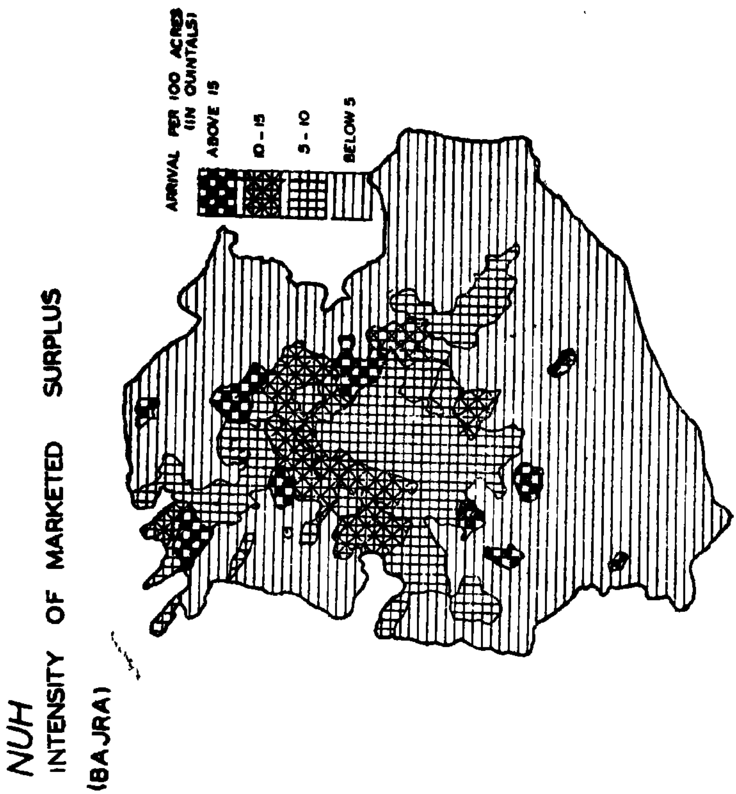

NUH
INTENSITY OF MARKETED SURPLUS
(BAJRA)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 15
10 - 15
5 - 10
BELOW 5

Fig. 5.5 (c)

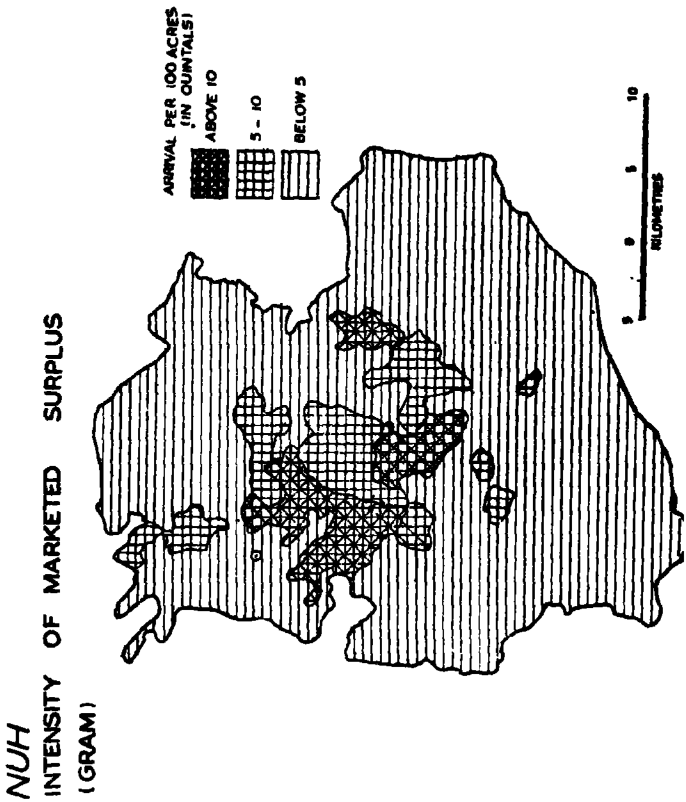

NUH
INTENSITY OF MARKETED SURPLUS
(GRAM)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 10
5 - 10
BELOW 5
KILOMETRES

Fig. 5.5 (d)

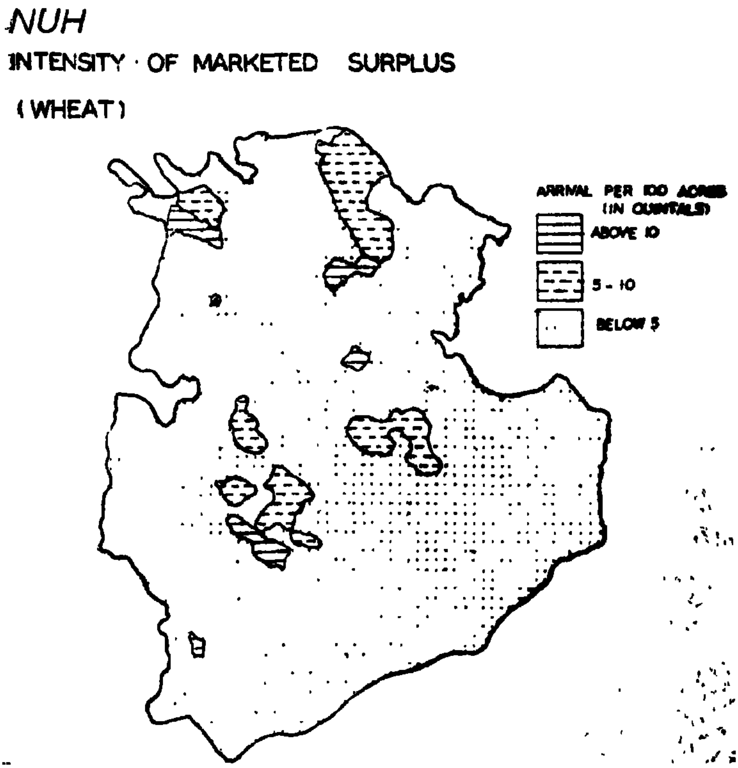

NUH
INTENSITY OF MARKETED SURPLUS
(WHEAT)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 10
5 - 10
BELOW 5

Fig. 5.5 (e)

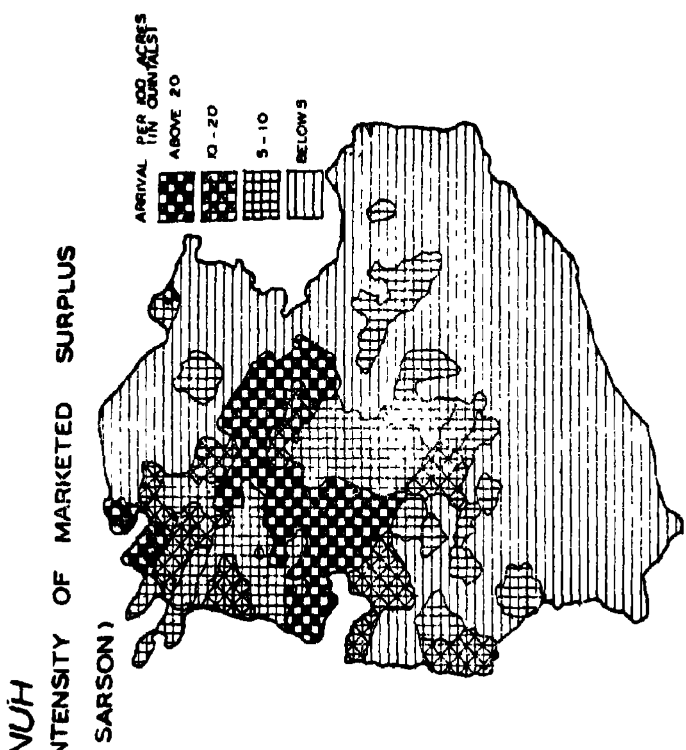

NUH
INTENSITY OF MARKETED SURPLUS
( SARSON )
ARRIVAL PER 100 ACRES (IN QUINTALS)
ABOVE 20
10 - 20
5 - 10
BELOW 5

Fig. 5.5 (f)

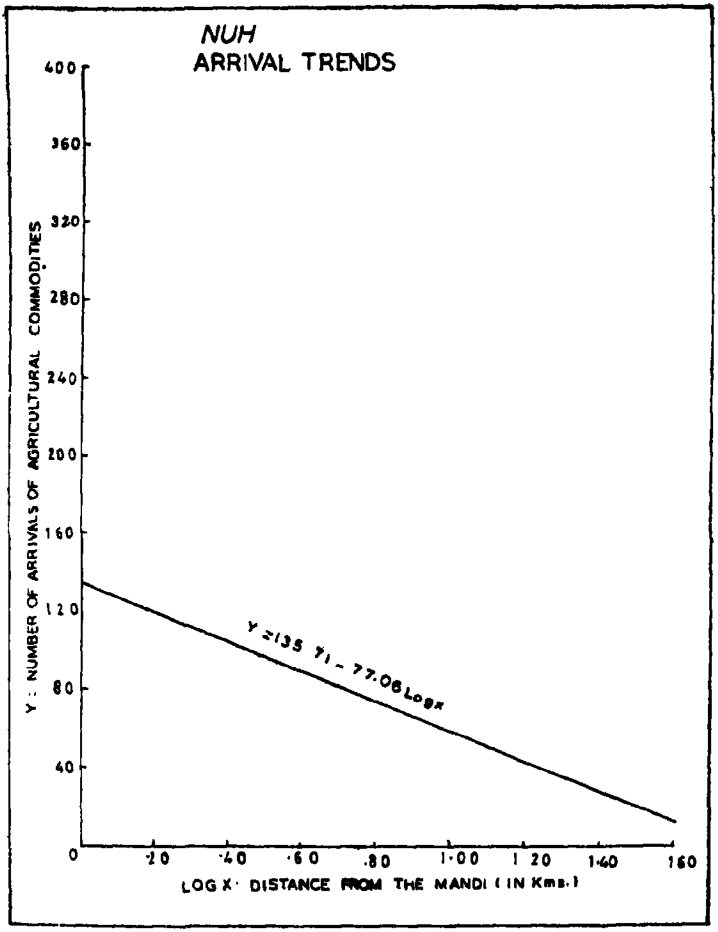
Here also the association between distance from the mandi (log X) and the frequency of arrivals is stronger (r=—.39) for the villages which do not have road linkages with their mandis as compared to those villages which are on the road (r=—.16).

The arrival pattern of wheat and barley has shown rather reverse trend. As we go away from the mandi, the proportion of arrival increases. From the villages which are within 5 kms. from the mandi, the proportion of wheat is 10.51 per cent to the zone's total marketed wheat. It rises to 25.67 Per cent for the second inner zone, 30.22 per cent for third zone, declines to 25.62 per cent for fourth and 7.98 per cent for the outer most zone. Average wheat arrival size per village is 27 quintals per village for those villages which are in the nearest zone, 35 quintals for the second zone, 38 quintals for 10 to 15 kms. zone, 51 quintals per village for the villages which are located within the distance zone which extends from 15 to 20 kms. and 24 quintals (lowest) per village for the villages which are located more than 20 kms. away from the grain market.

The proportion of barley from each zone to the total marketed barley is 10.44 per cent from the inner most zone, 27.20 per cent from secoud zone (5 to 10 kms.), 28.30 per cent from third zone (10-15 kms.), 24.6 per cent from fourth zone (15 to 20 kms.), and 9.46 per cent from the fifth zone. Thus, after 15 kms. distance, from where 66 per cent barley arrives, the proportion of barley arrival declines with the increase in distance.

The arrival of barley per village is 90 quintals from the villages which are within 5 kms. radius and rises to 113 quintals from 5 to 10 kms., 117 quintals from 10 to 15 kms., 77 quintals from 15 to 20 kms. and 58 quintals from a distance more than 20 kms. from the mandi.

Of the total marketed sarson, 17.30 per cent comes from the inner most zone, 29.29 per cent from the second zone,



NUH
ARRIVAL TRENDS
400
360
320
280
240
200
160
120
80
40
0
Y : NUMBER OF ARRIVALS OF AGRICULTURAL COMMODITIES
Y =135 71 - 77.06 Logx
·20
·40
·60
·80
1·00
1 20
1·40
160
LOG X · DISTANCE FROM THE MANDI ( IN Kms.)


Fig. : 5.6

21.36 per cent from third zone, 16.14 per cent from fourth zone and 15.91 per cent from the fifth zone. Per village sarson arrival is highest (217 quintals) for the villages which are located in the inner most zone. It gradually declines to 90 quintals per village for the villages which are located within the distance zone of 15 to 20 kms. The villages which are beyond 20 kms., their average sarson arrival size is 114 quintals.

**Table No. 5.8**

**Nuh-Proportion of different crops in Different distance zones**

| *Distance from the Mandi* | *Wheat* | *Barley* | *Sarson* | *Gram* | *Bajra* |
|---|---|---|---|---|---|
| Less than 5 kms. | 3.30 | 19.10 | 61.14 | 12.55 | 3.91 |
| 5—10 kms. | 4.32 | 26.72 | 55.58 | 10.98 | 2.40 |
| 10—15 kms. | 5.85 | 31.95 | 46.58 | 13.83 | 1.79 |
| 15—20 kms. | 6.24 | 39.94 | 44.28 | 12.59 | 1.94 |
| More than 20 kms. | 2.85 | 19.68 | 63.94 | 13.03 | 0.50 |

The average arrival size of gram is lowest (13.79 quintals per village) for the villages which are more than 20 kms. away from the mandi. It is highest (26.97 quintals) for the villages which are located within the distance of 10 to 15 kms. away from the town. The average arrival size of gram is also highest (64 quintals per village) in this zone.

31.44 per cent of the total marketed bajra of the mandi comes from the villages which are located at distance of 5 to 10 kms. from the mandi. Villages beyond 20 kms. contribute only 3.09 per cent of the mandi's total marketed bajra. The arrival of bajra per village is 28 quintals from the villages which are located within a distance of 5 kms. from the mandi. The villages which are more than 20 kms. away from the mandi, their average arrival size is as low as 6 quintals per village.

In the inner most zone, the proportion of sarson is 61.14 per cent (maximum), that of barley 19.10 per cent, gram 12.55, bajra 3.91 per cent and wheat only 3.30 per cent to the total marketed surplus of the zone. In the second inner most zone, the proportion of sarson is 55.58 per cent, barley 26.72 per cent, gram 10.98 per cent, wheat 4.32 per cent, bajra only 2.40 per cent of the zones total. In the third zone, sarson is still the dominating crop but its proportion declines further to 46.58 per cent. The proportion of barley is 31.95 per cent, gram 13.83, wheat 5.85 per cent and bajra less than 2 per cent. In the fourth zone, the proportion of sarson further decreases further to 44.28 per cent. Barley forms 39.94 per cent, gram 12.59 per cent and bajra less than 2 per cent. Proportion of sarson is maximum (63.94 per cent) for the villages which are more than 20 kms. away from the mandi. The proportion of barley is 19.68 per cent. of gram 13.03 per cent, of wheat 2.85 per cent and that of bajra, it is only 0.50 per cent.

**5.3.4 Punahana Mandi :**

The supply area of Punahana mandi is more towards the western side of Punahana because Nuh and F.P. Jhirka mandis are far away. Whereas in the north-east-Hodel is a competitive mandi. Most of the villages, which contribute highest arrival of mator (above 5 quintals per hundred acres), are located in the northern side of the mandi. Whereas the villages of highest gram arrivals are in the south-west. The wheat supply zone for Punahana is spreading in an elongated fashion in the east-west direction along Nagina-Hodel link road. The hinterland maps (Fig. No. 5.7) for all the major commodities clearly show that most of the villages which contribute least have marginal locations in their respective hinterlands. With the increasing distance, the arrival of each commodity does not decrease significantly. Barley, arhar and total arrival of all commodities per hundred acres decrease significantly with the increasing distance of the villages from the mandi centre. The coefficient of correlation between arrival of barley per hundred acres and distance of the villages from the mandi centre is —.29 which is highly

PUNAHANA

INTENSITY OF MARKETED SURPLUS

(ARHAR)

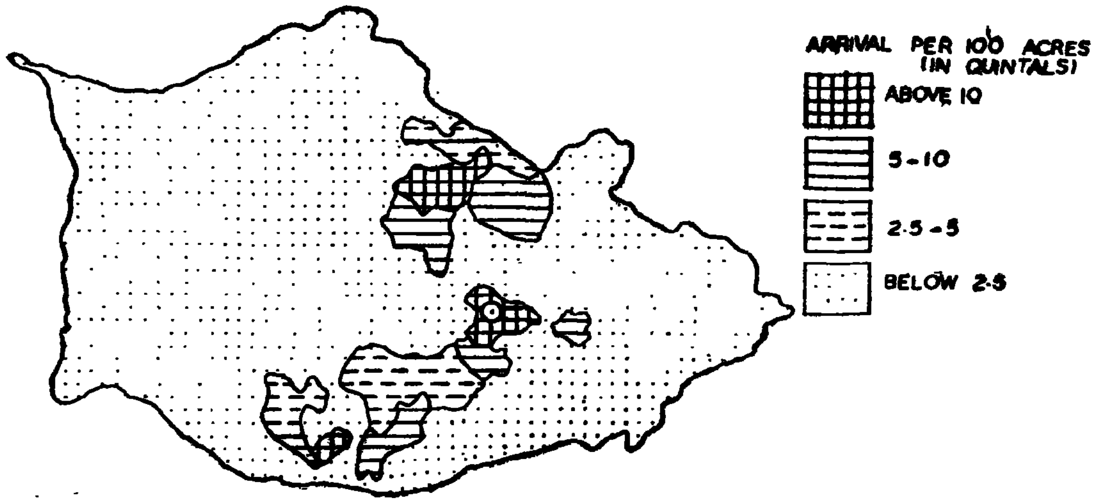



Fig. : 5.7(a)

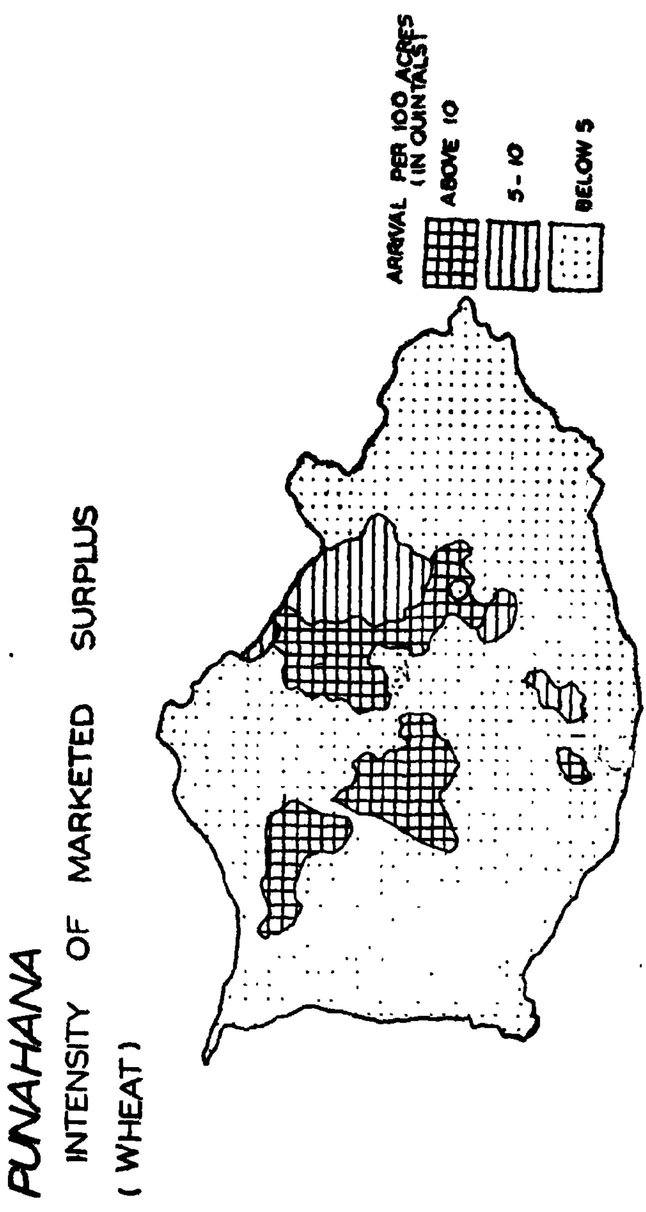

PUNAHANA
INTENSITY OF MARKETED SURPLUS
( WHEAT )
ARRIVAL PER 100 ACRES
( IN QUINTALS )
ABOVE 10
5 - 10
BELOW 5

Fig. : 5.7 (b)

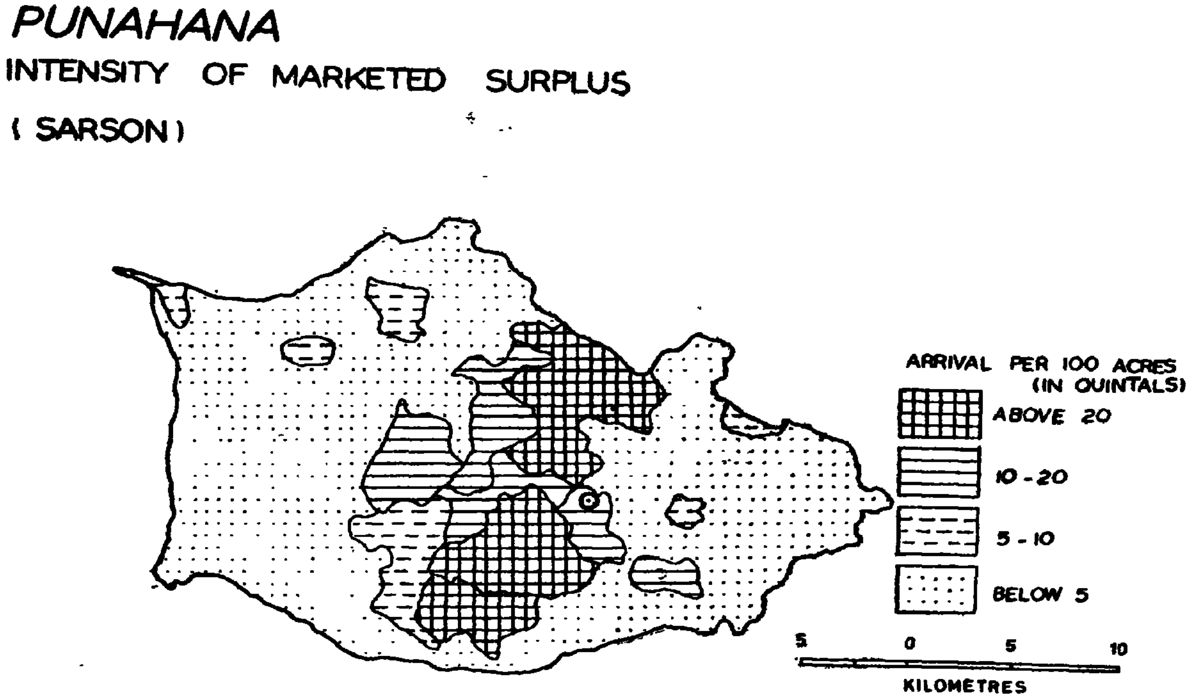

PUNAHANA
INTENSITY OF MARKETED SURPLUS
( SARSON )
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 20
10 - 20
5 - 10
BELOW 5
5
0
5
10
KILOMETRES

Fig. : 5.7 (c)

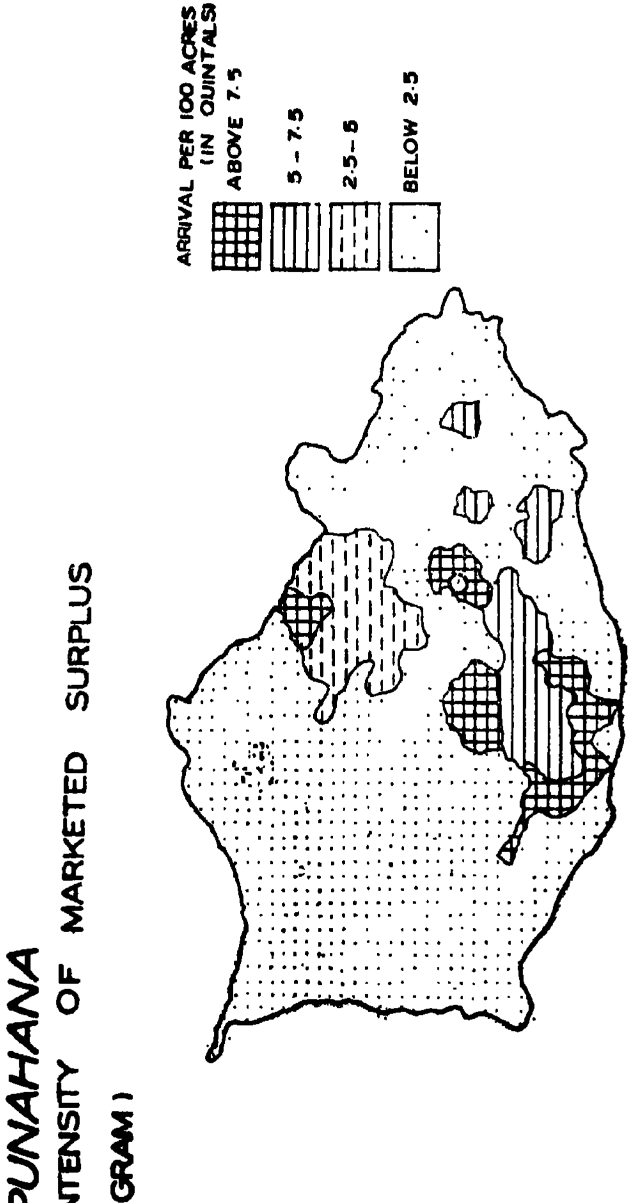

PUNAHANA
INTENSITY OF MARKETED SURPLUS
( GRAM )
ARRIVAL PER 100 ACRES
( IN QUINTALS)
ABOVE 7.5
5 – 7.5
2.5 – 5
BELOW 2.5

Fig. : 5.7 (d)

PUNAHANA

INTENSITY OF MARKETED SURPLUS
(MATOR)

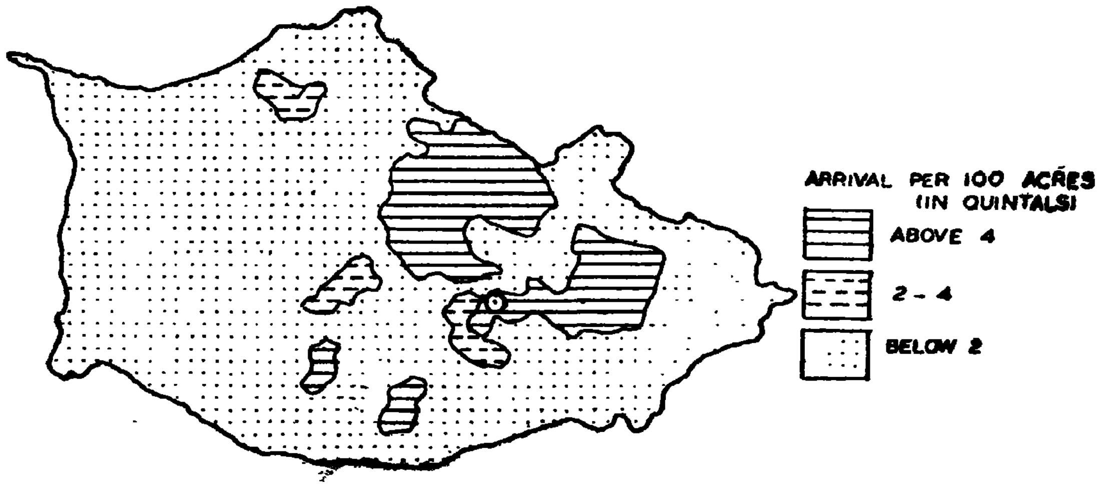



Fig. : 5.7 (e)

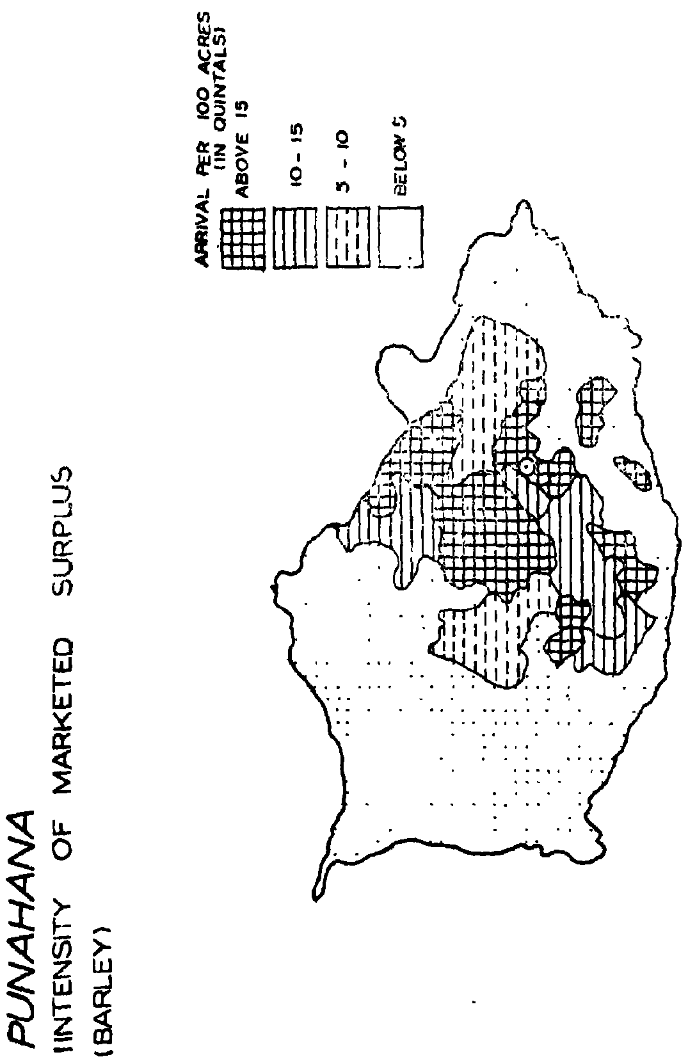

PUNAHANA
INTENSITY OF MARKETED SURPLUS
(BARLEY)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 15
10 - 15
5 - 10
BELOW 5

Fig. : 5.7 (f)

significant and shows negative association. The correlation with its frequency is —.28 which is also significant. As we go away from Punahana mandi, the arrival of all commodities per hundred acres decreases as shown by negative r of —.29. The frequency of all commodites if taken collectively also declines significantly as reflected from 'r' value of —.295.

The northern side of the mandi area is highly flood affected where mator is most preferable commodity. Here the land is available for cultivation very late, after the flood water has receded. This flood affected land is being used most suitably for mator cultivation whereas the south-western part of the mandi hinterland is dry-land and gram is being cultivated in this part.

The regression analysis gives the equation for the log-linear relationship between distance from the mandi (log X) and frequency of arrivals*. The line plotted in figure No. 5.8, reveals a negative relationship in addition to a fairly close fit to the scatter of dots. Here also, a large variation between estimated frequency of arrivals and observed frequency of arrivals for a large number of villages is noticed as shown in Fig. 5.8. The association between distance from the mandi (log X) and the frequency of arrivals of agricultural products (Y) is much stronger for the villages which are deprived of direct road linkages (with 'r' value —.145) as compared to the villages which are directly linked by road to the mandi (with 'r' value —.20).

The zone between 5 to 10 kms. distance from the mandi, contributes 47.6 per cent (maximum) to the total marketed wheat in Punahana. It declines sharply as we go away from the mandi centre. Hardly 1.45 per cent wheat comes beyond 20 kms. from the mandi.

The average arrival size per village is 86 quintals for the villages which are located within a distance range of 5 kms.

* $Y = 213.86 - 148.46 \log X$.

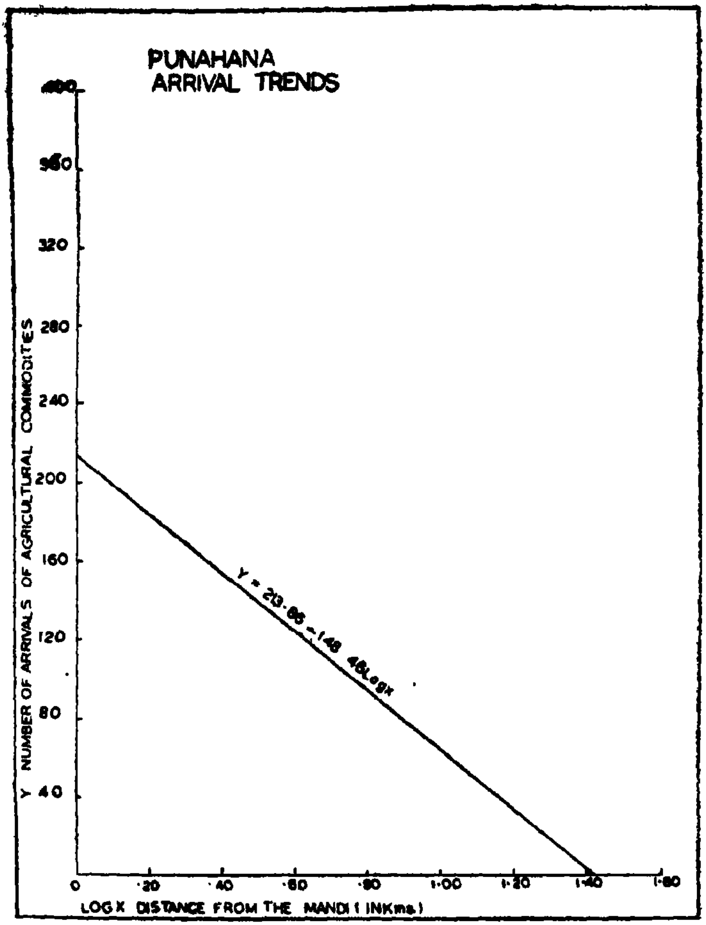

PUNAHANA
ARRIVAL TRENDS
Y NUMBER OF ARRIVALS OF AGRICULTURAL COMMODITIES
320
280
240
200
160
120
80
40
Y = 213·66 – 148 48Logx
0
·20
·40
·60
·80
1·00
1·20
1·40
1·60
LOG X DISTANCE FROM THE MANDI ( IN Kms )

Fig. : 5.8

The largest arrival size (92 quintals) is recorded for the villages located between the distance of 5 to 10 kms. from the market. Further outwards, this average size gradually declines to 24 quintals (minimum) for the villages which are more than 20 kms, away from the grain market.

Catchment area of Punahana mandi is relatively small, as a result of which about 83 per cent of the total marketed barley comes from villages which are just within a distance range of 10 kms from the mandi. 10.75 per cent of barley is recorded from the third zone (10 to 15 kms ), 1.52 per cent from 15 to 20 kms. and 4.91 is received from outer most areas. The barley arrivals per village too show a declining trend from 154 quintals per village from the villages which are within 5 kms. distance from the mandi, 102 quintals from the second zone, 48 quintals from third zone to 21 quintals from the fourth zone. However, the arrivals per village from the villages which are more than 20 kms. away from the mandi amount to 48 quintals.

49.4 per cent of sarson comes from the villages which are located within a distance of 5 to 10 kms. from the mandi. The settlements which are within 5 kms. radius contribute 30.96 per cent sarson. Remaining 20 per cent sarson comes from the villages which are located beyond 10 kms. away.

The arrival per village decreases from 139 quintals per village for the villages which are within the radius of 5 kms. outward to 21 quintals per village for the villages which are located between 15 to 20 kms. away from the market. The average arrival size of the villages which are located beyond 20 kms. is 65 quintals.

In inner most zone, 34.24 per cent marketed surplus is of barley, 32.12 per cent of sarson, 15.63 per cent of wheat, 10.38 per cent is of gram and 7.63 per cent is of bajra. In the second inner most zone, sarson becomes the first major contributor (37.14 per cent) to the total marketed surplus of the zone. Proportion of barley is 28.62 per cent, of wheat 18.21 per cent, of gram 10.69 per cent and of bajra 5.34 per cent.

In the third zone (10-15 kms. distance), except bajra, one finds relatively less variations in the proportion of wheat, barley, sarson and gram to the total marketed surplus. In the fourth zone, proportion of wheat arrival is 38.57 per cent, barley 18.94 per cent, sarson 28.87 per cent, gram 13.28 per cent and that of bajra only 0.35 per cent. Villages which are beyond 20 kms., contribute 39.11 per cent arrival of barley, 38.23 per cent sarson, 6.94 per cent wheat, 13.95 per cent gram and 1.77 per cent bajra for the mandi.

**Table No. 5.9**

**Punahana-Proportion of Different Crops in Different Distance Zones**

| *Distance from the Mandi* | *Wheat* | *Barley* | *Sarson* | *Gram* | *Bajra* |
|---|---|---|---|---|---|
| Less than 5 kms. | 15.63 | 34.24 | 32.12 | 10.38 | 7.63 |
| 5—10 kms. | 18.21 | 28.62 | 37.14 | 10.69 | 5.34 |
| 10—15 kms. | 21.36 | 22.48 | 33.07 | 20.50 | 2.58 |
| 15—20 kms. | 38.57 | 18.94 | 28.87 | 13.28 | 0.35 |
| More than 20 kms. | 6.94 | 39.11 | 38.23 | 13.95 | 1.77 |

### 5.3.5 Sohna Mandi :

One may draw important conclusions from attached maps showing arrival of different commodities per hundred acres. A prominent feature about Sohna mandi is that its hinterland makes 'D' shaped pattern (Fig. No. 5.9). Western side of the mandi hardly contributes anything as marketed surplus. The major factor which distort the circular concentric zones is the Aravalli range, which serves as the natural hindrance and does not permit the villagers from West of Aravalli to bring their produce at Sohna. Secondly, because of uneven and hilly topography, the surplus is also limited and villages are sparsely distriuted. The mandi is located in the extremely western end of its hinterland. The zone of highest arrival intensity is almost contiguous though elongated north-south wards. The villages which contribute marginally are scattered along the

periphery of the mandi hinterland. Apart from these, villages there are villages located relatively at distant places in the hinterlands of the adjacent mandis, which occasionally send their produce. Thus, there is inter-mandi hinterland flow of marketable agricultural produce in the region. The relationship between average arrival size,[12] and distance from the mandi centre is in positive direction. As we go away from the mandi centre the farmers prefer to bring their produce in relatively larger quantities though less frequently. But statistically, this relationship is not significant for Sohna mandi. There is negative association between total arrivals, arrival per hundred acres and frequency of arrivals on one side and distance from the mandi centre on the other hand. In case of Sohna, this relationship is significant for all the major products except gram. The coefficient of correlation between total arrival and distance from the mandi is highest i.e. —.436 which is highly significant. Taking commodity wise for wheat, sarson, bajra and barley, the 'r' values are —.27, —.30, —.36, —.40 respectively. The above 'r' value show that the relationship between distance from Sohna mandi and arrival of above commodities is negative and significant. The hypothesis that the arrival per hundred acres decreases as we go away from Sohna mandi centre is not very clear from the maps in case of wheat and sarson. But if the inter-correlation values are analysed, the association between distance from the Sohna mandi centre and arrival per hundred acres of wheat, sarson, bajra, barley and total arrival of all commodities turns to be negative and highly significant with 'r' values —.28, —.38, —.36, —.35, and —.39 respectively. The 'r' values between distance from the mandi and the frequency of arrivals of wheat, sarson, bajra, barley and total frequency of all commodities is —.29, —.38, —.37, —.38 and —.41. These values being highly significant and negative, support the hypothesis that the farmers of distant villages bring their produce less frequently as compared to the nearby villages. The data on the number of arrivals of agricultural commodities (Y) and distance from the

12. Average arrival size has been abtained simply by dividing the total marketed a gricultural product with the total frequency of sellers of agrieultural product.

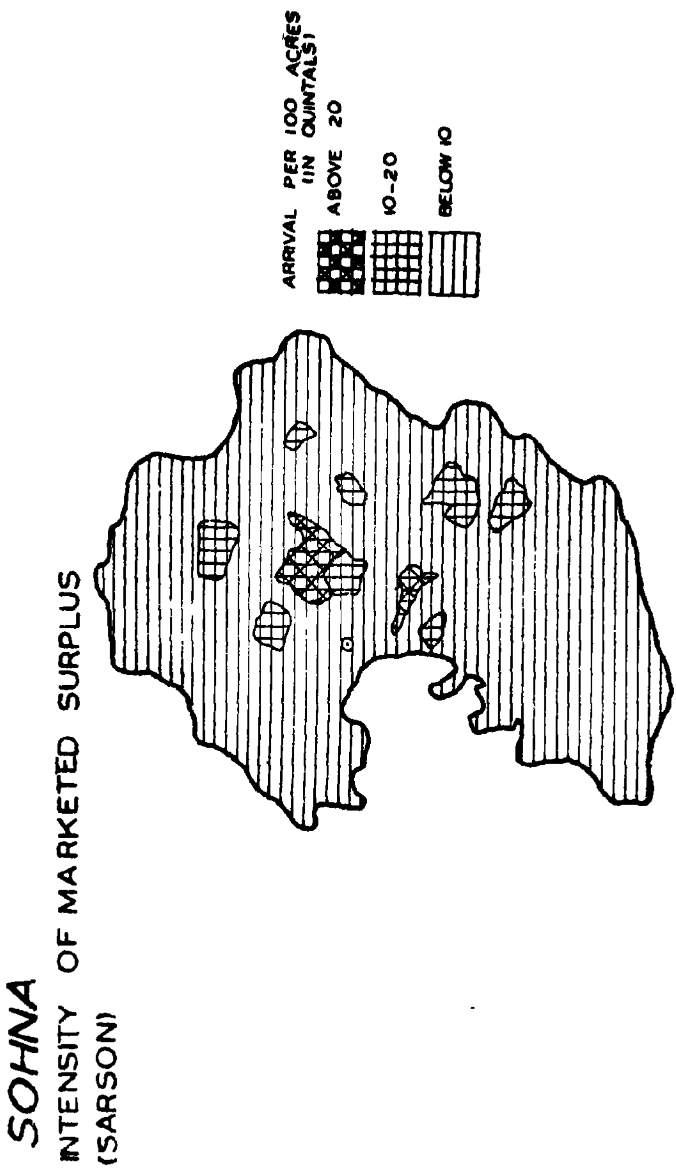

SOHNA
INTENSITY OF MARKETED SURPLUS
(SARSON)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 20
10-20
BELOW 10

Fig. : 5.9 (a)

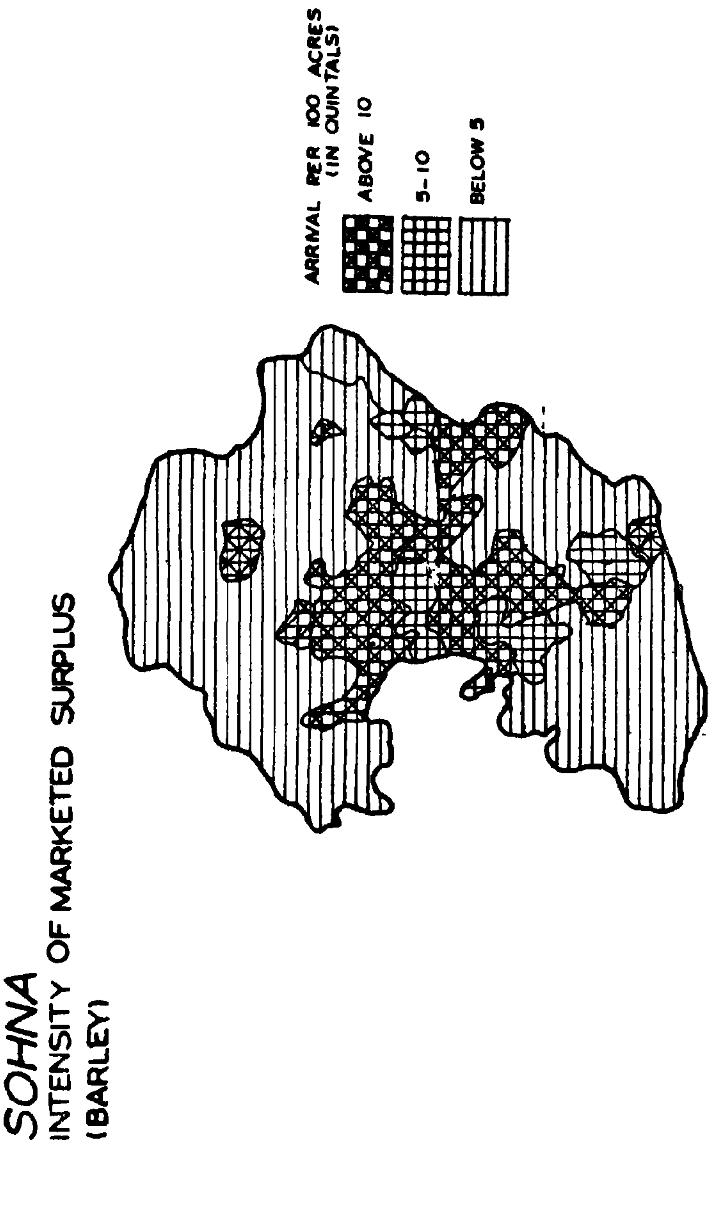

SOHNA
INTENSITY OF MARKETED SURPLUS
(BARLEY)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 10
5-10
BELOW 5

Fig. : 5.9 (b)

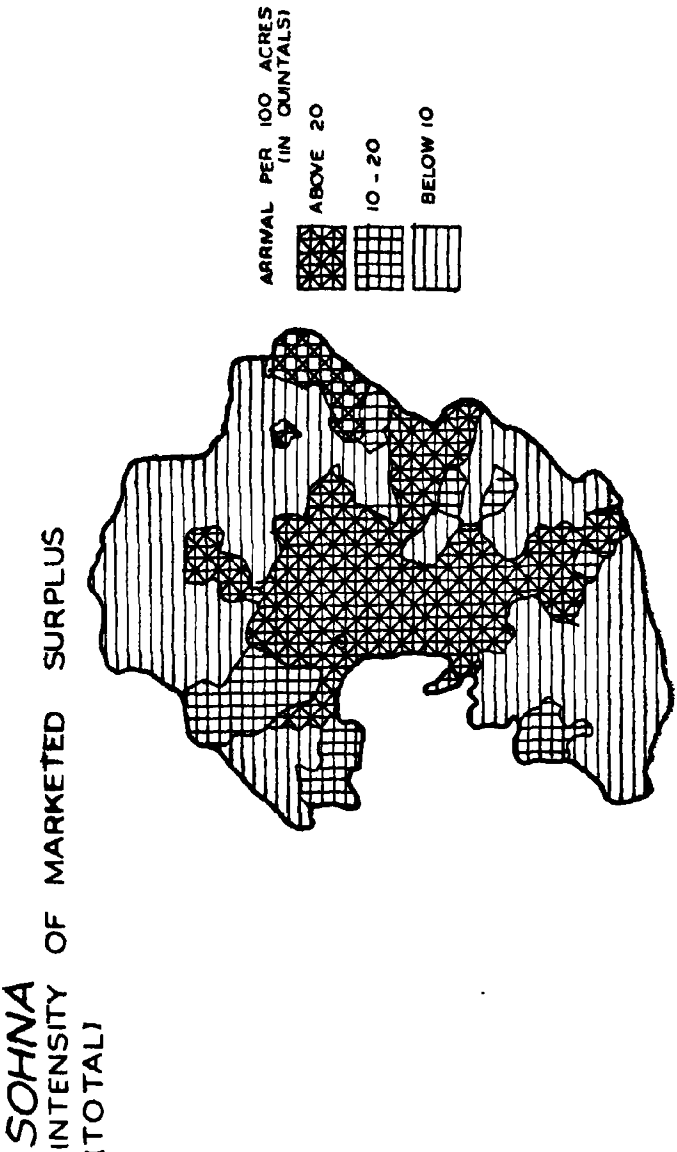

SOHNA
INTENSITY OF MARKETED SURPLUS
(TOTAL)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 20
10 - 20
BELOW 10

Fig. : 5.9 (c)

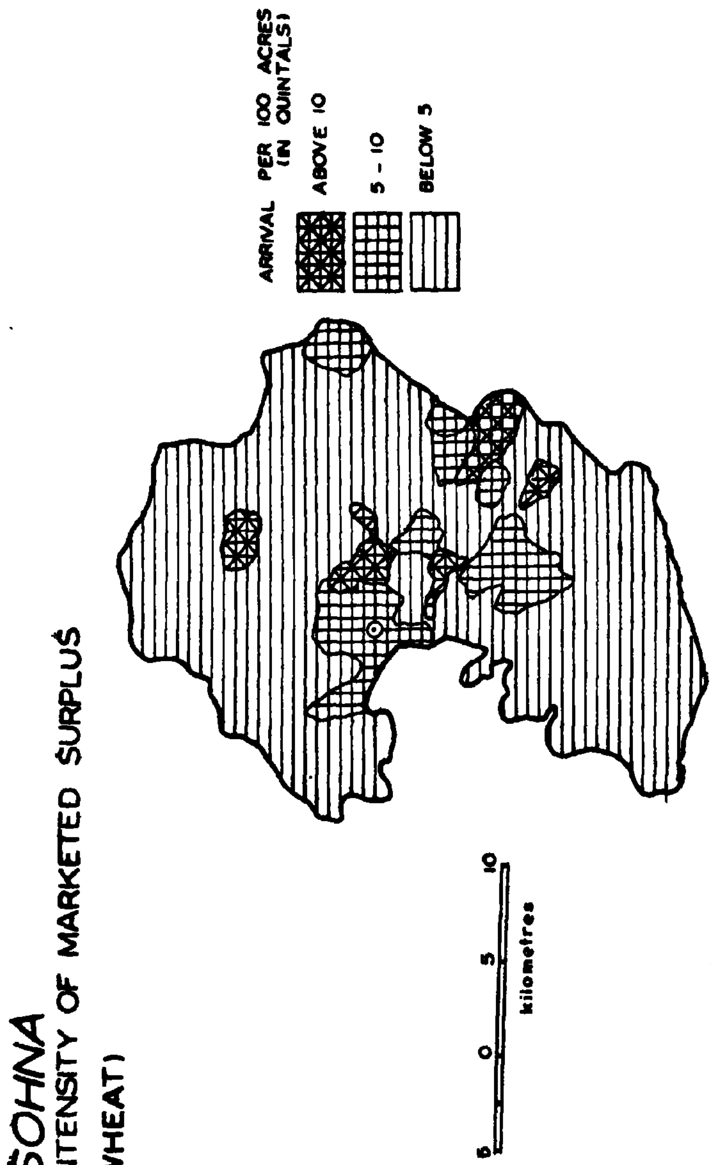

SOHNA
INTENSITY OF MARKETED SURPLUS
(WHEAT)
ARRIVAL PER 100 ACRES
(IN QUINTALS)
ABOVE 10
5 - 10
BELOW 5
5 0 5 10
kilometres

Fig. : 5.9 (d)

mandi (X), if plotted on a scatter diagram depicts a curvilinear pattern. Thus the best fit line will make a curve. For the sake of simplicity 'X' variable has been transformed into log which gives the equation for regression line for Sohna mandi*. The regression line shows the negative association between distance from the mandi (log X) and frequency of arrivals (Y) at Sohna mandi. With the value of X replaced by log X in formula for the correlation coefficient, 'r' coefficient is calculated to be r 0.292 (as compared with 0.17 in linear relationship). Thus the relationship shown in fig. No. 5.10 is log linear where the horizontal scale of actual distance from the mandi has been replaced by logs.

Better the road accessibility, higher will be the frequency of agricultural arrivals. Around 75 per cent villages of Haryana state are linked with pucca roads. After division of Punjab and Haryana, there has been some three times increase in length of roads. These roads include state highways, district roads, village link roads, but the major length is of village links roads. As is evident from the road development in the region, quicker means of transport have replaced the traditional transport means. Trucks, tempo, tractor-trolleys have become more popular in bringing the agricultural produce from village to markets.[13] So the villages located along the transport arteries which link them straight to the mandi centre bring their produce from far distances with more frequency as compared to the villages which are away from the roads. But these variations may be less in those areas where mode of transportation is bullock-cart or some other traditional means. However, the bullock-carts can move more efficiently if pucca roads are available. The association between distance from the mandi centre and frequencies of arrivals of agricultural produce is stronger in case of villages which are on the roads (—.32) as compared to the villages away from the roads (—.18).

* $Y = 143.27 - 101.25 \log X$.

13. Directorate of Marketing and Inspection, Ministry of Rural Reconstruction, Government of India (1981), Marketing of wheat in Punjab and Haryana, (Faridabad), pp. 10-11.

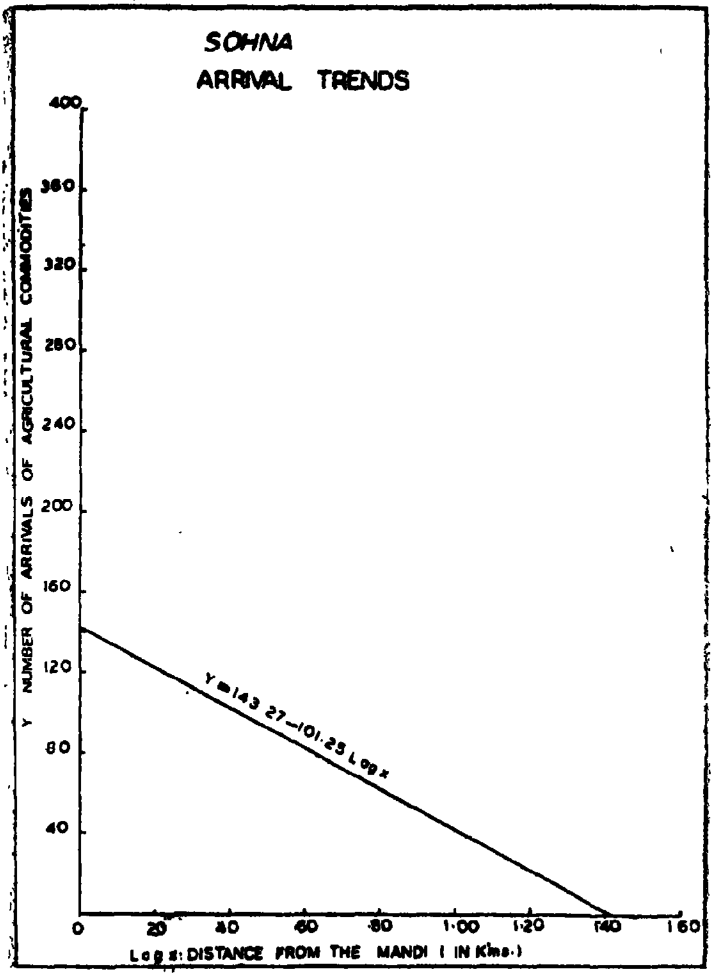

SOHNA
ARRIVAL TRENDS
Y NUMBER OF ARRIVALS OF AGRICULTURAL COMMODITIES
400
360
320
280
240
200
160
120
80
40
Y = 143 27 – 101.25 Log x
0
20
40
60
80
1·00
1·20
1·40
1·60
Log x: DISTANCE FROM THE MANDI ( IN K'ms.)

Fig. : 5.10

Twenty-five per cent of wheat comes from less than 5 kms. from Sohna mandi (table 5.1a). Forty-eight per cent is contributed by the second zone, The third zone contributes 15 per cent. From areas beyond 15 kms., Sohna mandi receives only 12 per cent wheat. Leaving inner most zone, the percentage of wheat arrival declines with increase in distance from the mandi. Anyhow, from the first zone, the arrival per village is very high. However from the second inner most zone, the arrival per village is the highest i.e., 79 quintals. From the third concentric zone, the arrival of wheat per village is 44 quintals. The wheat arrival per village is lowest (15 quintals) from the farthest zone of more than 20 kms.

The arrival patterns of sarson (as percentage to the total) for different distance zones is very similar to wheat. The first inner most zone contributes sufficiently high per cent (34 per cent) of the total sarson arrivals at Sohna mandi. The villages of second nearest concentric zone, bring maximum proportion (41.59 per cent) of the mandis total sarson. The villages of third and fourth zones, contribute 14 and 7 per cent barley respectively. The villages which fall in the last zone, hardly contribute 4 per cent to the total barley arrivals in the mandi.

The arrival of barley per village is very high (i.e. 385 quintals) in the mandi from the villages which are located within a distance of 5 kms. from the mandi. Barley arrival from 5 to 10 kms. zone amounts to 247 quintals. It further decreases to 131, 108 and 35 quintals for the villages of third, fourth and fifth zones (Table No. 5.2b).

Arrival pattern of sarson is the most·ideal example to support the hypothesis that with the increasing distance from the mandi point, the marketed surplus declines. The villages falling within 5 kms. distance from the mandi could contribute 40.30 per cent of the total sarson marketed in the mandi, 36.22 per cent comes from 5 to 10 kms. zone, 10.67 per cent from the next outer zone and 5.16 per cent from the outermost zone.

Per village sarson arrival is highest (137 quintals) from the inner most concentric zone. It gradually declines to a minimum of 19 quintals per village for the villages which fall in the outer most zone.

Gram arrival pattern does not support the hypothesis of declining arrival size with increasing distance. Though first and second zones contribute high proportion of the product but it is only the third zone which contributes the maximum (29 per cent). 15.54 per cent and 4.73 per cent of the total gram comes from fourth (15-20 kms.) and fifth zone beyond 20 kms.) respectively.

Arrival pattern of bajra also supports the above hypothesis. The nearest villages of the mandi, which are located within a distance of 5 and less than 5 kms. bring 45.99 per cent of the mandi's total marketed bajra. The second zone adds 36.62 per cent to the mandi's total bajra. Thus the villages located within the distance of 10 kms. from the mandi account for 72 per cent of the mandi's total bajra. It sharply declines beyond 10 kms. The third zone contributes 8.37 per cent, fourth zone contributes 4.90 per cent and the fifth zone contributes 4.12 per cent.

The villages which are within the distance range of 5 kms. from mandi record 100 quintals per village. From the second zone, the arrival per village declines sharply to 47 quintals per village. It further decreases to 24 quintals in the distance zone of 10 to 15 kms. It is only 15 quintals per village from the distance zone which covers the villages which are more than 20 kms. away from the market centre.

Within the radius of 5 kms. the proportionate share of barley is the highest (i.e. 57.46 per cent) to the total of all the five commodities analysed above. Sarson, bajra and wheat contribute 19.05, 13.82 and 8.43 per cent respectively to the total marketed surplus in this inner most zone. In the second zone also the proportion of barley is very high (61.06 per cent). Sarson is the second major commodity with a proportion of

Table No. 5.10

Sohna-Proportion of Different Crops in Different Distance Zones

| *Distance from the Mandi* | *Wheat* | *Barley* | *Sarson* | *Gram* | *Bajra* |
|---|---|---|---|---|---|
| Less than 5 kms. | 8.43 | 57.46 | 19.05 | 1.25 | 13.82 |
| 5—10 kms. | 13.77 | 61.06 | 14.72 | 0.99 | 9.46 |
| 10—15 kms. | 13.56 | 62.86 | 13.31 | 3.63 | 6.64 |
| 15—20 kms. | 10.87 | 59.17 | 18.61 | 3.79 | 7.57 |
| More than 20 kms. | 14.18 | 55.12 | 19.21 | 1.76 | 9.73 |

14.72 per cent while bajra and wheat have inter-changed their respective position and gram remained the least in quantity in this zone. Further away, in the third concentric zone, the proportion of barley increases to 62.86 per cent. Here, wheat occupies second position, though its proportion is only 13.56 per cent. Sarson, bajra and gram account for 13.31 per cent, 6.64 per cent and 3.63 per cent respectively. In the fourth concentric zone the proportion of barley is 59.17 per cent sarson 18.61 per cent. Third, fourth and fifth are wheat, bajra and gram, which together account for hardly 22 per cent of the total marketed surplus. In the outer most zone, the relative position of individual crops is similar to the adjacent inner zone.

## 5.4 Conclusions :

In general, there is close association between the distance from the mandi (log X) and the number of arrivals of all commodities. The coefficient of correlation between the above two variables is —.37 if all the five mandis are taken together. For all the five mandis, the pattern of the intensity of arrivals from different zones is highly variable. The Aravalli range and political boundaries are the main factors responsible for the distortion of distance-decay patterns. The hypothesis that as the distance increases the

arrival frequency declines, does not hold true in case of the villages which are highly accessible to the mandi by the direct road linkages, particularly in case of Nuh, Hodel and Punahana mandis. This fact supports the hypothesis that if the villages of mandi catchment area have very high degree of direct road linkages to the mandi centre, the constraint of distance-factor is subdued. A comparison of actual mandi hinterlands with the notified mandi areas, brings out large descripancies.

Percentage of wheat arrivals shows a very clear declining trend from 5 to 10 kms. distance zone to the outer most zone beyond 20 kms. particularly in case of Sohna and Punahana. Its arrival per village goes decreasing outwards in case of Sohna, Gurgaon, Hodel and Punahana mandi centres. In contrast, in case of Nuh Mandi, the average wheat arrivals per village and the percentage share of each distance zone goes on increasing from the mandi centre to the periphery.

In case of barley, the arrival patterns are not clear for Gurgaon. For Nuh, the arrival intensity increases upto a distance of 15 kms. The barley arrival patterns, as emerged from Sohna, Hodel and Punahana mandis, confirm the declining trend.

Arrival pattern for sarson indicates that for all the five mandis, as the distance increases, the arrival decreases. The arrival pattern of gram is not very clear. Except Gurgaon, for all other mandis the arrival intensity declines with distance.

Proportion of barley arrivals to the total varies from 55.12 per cent to 62.86 pent cent in different distance zones. Gram is the least contributor towards total marketed gram in each distance zone and mandi.

The proportion of barley is very high for Hodel, ranging from 45.84 per cent to 64.50 per cent for different zones. At Punahana mandi, the variations in the proportion of different commodities is not that large. In the inner most zone, barley

is major contributor to total arrivals with its share as 34.24 per cent. In the second zone, proportion of sarson is the highest (37.14 per cent). Further away, in the third zone sarson remains the major contributor with a proportion of 33.07 per cent. In the distance zone from 15 to 20 kms. the major proportion is that of wheat (38.57 per cent). Barley is again the first dominating commodity received in the mandi from the villages which are beyond 20 kms.

Sarson has the highest proportion in all the zones of Nuh Mandi. The values range from 44.28 to 63.94 per cent. Proportion of sarson declines outwards and that of wheat and barley increases with an increase in distance from the mandi centre.

The proportion of wheat is very high for all the zones of Gurgaon mandi and varies between 57.20 per cent to 89.41 per cent.

# 6

# Hierarchy of Mandi Centres

## 6.1 Introduction :

In this chapter, hierarchy of the mandi centres based on market arrivals and on transport nodality has been worked out. In the later part of the study, a comparison has been made between the hierarchical order of mandis and transport nodes in the region. Lastly, the hierarchy is determined by compositing arrival size and accessibility of the market centres.

## 6.2 Methodology :

Clark's (1956)[1] method of grouping as used by Mayfield (1967)[2] in his study of Central Place hierarchy and Barnum's (1966)[3] and Harriss's (1974)[4] works have provided the basis

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1. Philip J. Clark, "Grouping in spatial Distribution", *Science*, Vol. 123 (1956), pp. 123-125.
2. Robert C. Mayfield, "A Central Place Hierarchy in Northern India", in W.L. Garrison and D.F. Marble (ed.), *Quantitative Geography*, Part I, North Western University Studies in Geography, No. 130 (Evanston, 111, 1967).
3. H.G. Barnum, *Market Centres and Hinterlands in Baden-Wurttemberg*, Research Paper No. 103, Department of Geography, (Chicago; University of Chicago Press, 1966).
4. B. Harriss, "The Role of Punjab Wheat Markets as Growth Centres", *Journal of Geography*, Vol. 73 (1974), pp. 52-71.

to develop methodology for working out the hierarchy of mandi centres in this chapter.

However, as compared to the above studies, the present work is based on few variables and the method used has also been simplified. Same procedure has been followed for working out the mandi hierarchy and transport network nodality. Following Johnston (1966)[5], Berry & Garrison (1958)[6] and many others who determined the grades of Central places in their studies with the help of graphic array of points, the arrival of commodities sold in the mandi, storage capacity and population size have been represented graphically on x and y axis in this exercise. With the help of this graphic representation, a well marked hierarchy of mandi centres has emerged.

For the hierarchy based on the nodality of transport network, total population and accessibility scores were plotted on the two co-ordinates to determine the hierarchy of transport nodes in the study area. The population variable has been taken with the transport accessibility because both have well established positive relationship. The larger the size of a settlement, higher would be its accessibility. On the basis of the above two variables, transport nodes of different orders were determined.

The following indices have been used to identify various orders of mandi settlements in Delhi-Jaipur-Agra Triangle area.

## 6.3 Hierarchy based on Direct Connectivity :

Here the mandi centres have been arranged in various orders on the basis of Passenger flows. The data used is the

5. R.J. Johnston, "Central Places and the Settlement Pattern", *Annals*, Association of American Geographers, Vol. 56 (1966), pp. 541-549.
6. B.J.L. Berry and W.L. Garrison, "The Functional Bases of the Central Place Hierarchy", *Economic Geography*, Vol. 34, (1958), pp. 145-154.

direct bus service linkages between these mandi-points. By calculating and counting the direct-linkages from the plotted graph of bus routes the direction and dominance of various centres is quite prominent (Fig. No. 6.1). Gurgaon in north Deeg, Mathura and Bharatpur in south-east emerged most important centres as indicated by their highest linkages. There is very complicated net of interconnections between the mandi points in the eastern half of the region. In the western part of the region, where mandis are sparsely distributed, Jaipur is the most dominating centre, inspite of its marginal location. The interaction is more in eastern part as compared to western half of the region. These three centres of highest order are district headquarters with large population size and provide a number of central functions for which there is interaction even from distant areas.

Deeg has very high direct connectivity though it is not an important town nor it performs some important central functions. This is because it lies on the route in between Bharatpur, Gurgaon and Delhi. Bharatpur is linked to Gurgaon and Delhi through many routes; Bharatpur-Kosi-Delhi, Bharatpur-Punahana-Badkali-Delhi, Bharatpur-Kaman-Ferozepur Jhirka-Gurgaon, are the routes through which Bharatpur is linked to north. Since Deeg is located just near to Bharatpur along all these routes, the places which are linked to Bharatpur, are linked to Deeg also. Apart from this, it is also connected to its surrounding places in its vicinity. Similar is the case of its own but because of its strategic location on the cross roads. Jaipur and Agra, though largest cities with largest number of central functions, are second order settlements according to their direct connectivity score. It is because they are located on the extremely south-western and south-eastern corners. They must be having more than two third linkages on the other sides of the region. Both of the mandi points of Delhi state are almost isolated from rest of the region. Except Pataudi, all the other mandis of Haryana have moderately high direct-linkages and fall in the second level of hierarchy. The mandis with least interactions are Narela, Najafgarh, Khairthal. Kotputli, Chomu, Bandikui,

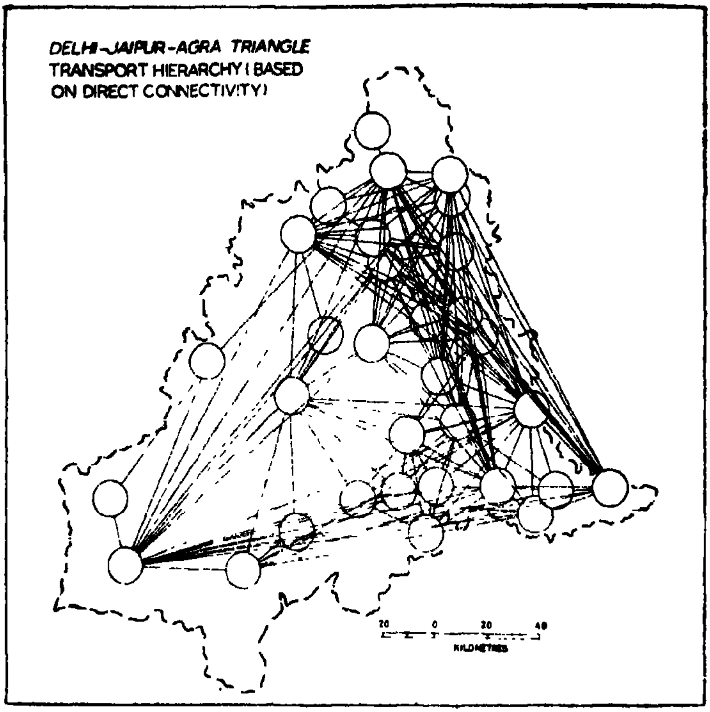

DELHI-JAIPUR-AGRA TRIANGLE
TRANSPORT HIERARCHY (BASED ON DIRECT CONNECTIVITY)
20 0 20 40
KILOMETRES

Fig. : 6.1

## Table No. 6.1

### Direct Connectivity

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Gurgaon | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 2. Agra | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | 1 | | | | 1 | 1 | 1 | 1 | | | | | | | 1 | | |
| 3. Jaipur | 1 | 1 | 0 | 1 | | | | | | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | 1 | | |
| 4. Mathura | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | | | | | 1 |
| 5. Kosi | 1 | 1 | | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | 1 | | | | 1 | | 1 | | | | 1 | 1 |
| 6. Hodel | 1 | 1 | | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | | | | | | | 1 | | | | 1 | | 1 | | | | 1 | 1 |
| 7. Palwal | 1 | 1 | | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | | | 1 | | | | | | | | 1 | | | | 1 | | 1 | | | | 1 | 1 |
| 8. Ballab-garh | 1 | 1 | | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | | | 1 | | | | | | | | 1 | | | | 1 | | 0 | | | | 1 | 1 |
| 9. Faridabad | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 0 | 1 | | 1 | | | 1 | | | | | | | | 1 | | | | 1 | 1 | 1 | | | | 1 | 1 |
| 10. Sohna | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | | 1 | | | 0 | | | | | 1 | | | | 1 | | 1 | | | | 1 | 1 |
| 11. Nuh | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 0 | 1 | 1 | | 1 | | | | | | | | 1 | | | | 1 | | 1 | | | | 1 | 1 |
| 12. F.P. Jhirka | 1 | | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | | | | | | | | 1 | | | | 1 | | | | | | 1 | 1 |
| 13. Alwar | 1 | | 1 | 1 | | | | | | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | | | 1 | | | | | | | |
| 14. Nagar | | | | 1 | 1 | | | | | | | 0 | 1 | 0 | 1 | | 1 | | 0 | 1 | 1 | 1 | 1 | | | | | | | | | | 1 | |
| 15. Deeg | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | 1 | 1 |

(Contd. on next page)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16. Khairthal | | | | | | | | | | | | | 1 | | | 0 | | | | | | | | | | | 1 | | | | | | | |
| 17. Kherli | | | 1 | | | | | | | | | | 1 | 1 | 1 | | 0 | 1 | | | | | | | | | | | | | | | | |
| 18. Dausa | 1 | | 1 | 1 | | | | | | 0 | | | 1 | | | | 1 | 0 | 1 | | | | 1 | 1 | 1 | | | | | | | | | |
| 19. Bandikui | | | | 1 | | | | | | | | | 1 | | | | | 1 | 0 | | | | | | | | | | | | | | | |
| 20. Mahwa | | | 1 | 1 | | | | | | | | | 1 | 1 | 1 | | | | | 0 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| 21. Bhusawar | | | | 1 | | | | | | | | | | 1 | 1 | | | | | 1 | 0 | 1 | 1 | | | | | | | | | | | |
| 22. Nadbai | 0 | 1 | 1 | 1 | | | | | | | | | | 1 | 1 | | | | | 1 | 1 | 0 | 1 | | | | | | | | | | | |
| 23. Baratpur | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | 1 | 1 | 1 | 0 | 1 | 1 | | | | | | | | 1 | 1 |
| 24. Fatepur Sikri | | 1 | 1 | 1 | | | | | | | | | | | 1 | | | 1 | | | | | 1 | 0 | 1 | | | | | | | | | |
| 25. Achhnera | | 1 | 1 | 1 | | | | | | | | | | | 1 | | | 1 | | 1 | | | 1 | 1 | 0 | | | | | | | | | |
| 26. Kotputli | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | | | 1 | | |
| 27. Rewari | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | 1 | | | | | | | | | | | 0 | 1 | 1 | | | | | 1 |
| 28. Pataudi | 1 | | | | | | | | 1 | | | | | | | | | | | | | | | | | | 1 | 0 | | | | | | |
| 29. Tauru | 1 | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | | | | | | | | | | | | | | | 1 | | 0 | | | | | 1 |
| 30. Najafgarh | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | | |
| 31. Nerela | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | | |
| 32. Chomu | | | 1 | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | 0 | | |
| 33. Kaman | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | | | | | | 1 | | | | | | | | | | | 0 | 1 |
| 34. Punahana | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | 1 | | | | | | 1 | | | | | 1 | | 1 | | | | 1 | 0 |

**Hierarchy of Market Centres**

(Based on Direct Connectivity)

| *I Order* | *Direct Conne-ctivity* | *II Order* | *Direct Conne-ctivity* | *III Order* | *Direct Conne-ctivity* |
|---|---|---|---|---|---|
| 1. Bharatpur | 25 | 1. Jaipur | 18 | 1. Nagar | 11 |
| 2. Mathura | 23 | 2. Sohna | 18 | 2. Mahwa-Mandawar | 9 |
| 3. *Gurgaon* | 22 | 3. Kaman | 17 | 3. Nadbai | 9 |
| 4. Deeg | 21 | 4. Kosi | 17 | 4. Dausa | 8 |
| | | 5. Palwal | 17 | 5. Achhnera | 8 |
| | | 6. Rewari | 16 | 6. Fatehpur Sikri | 7 |
| | | 7. Tauru | 16 | 7. Bhusawar | 6 |
| | | 8. Nuh | 16 | 8. Kherli | 4 |
| | | 9. Hodel | 16 | 9. Pataudi | 3 |
| | | 10. F.P. Jhirka | 16 | 10. Bandikui | 3 |
| | | 11. Faridabad | 16 | 11. Chomu | 2 |
| | | 12. Punahana | 15 | 12. Kotputli | 2 |
| | | 13. Alwar | 15 | 13. Khairthal | 2 |
| | | 14. Ballabgarh | 14 | 14. Najafgarh | 1 |
| | | 15. Agra | 14 | 15. Narela | 0 |

Pataudi, Kherli, Bhusawar, Fatehpur Sikri, Achhnera, Dausa, Nadbai, Mahwa-Mandawar and Nagar. These represent the IIIrd order transport focal points.

### 6.4 Hierarchy of Market Centres based on nodal Accessibility :

The nodal accessibility score is the composite of all the variables of the levels of transport network development for the mandi centres derived from graph theory. There is positive association between levels of transport development and the

population size of settlements. The big cities with numerous important central functions have high level of transportation network which link them functionally with smaller service centres in their respective nodal regions. The array of points in figure No. 6.2 shows the relationship between population size and the transport accessibility, The two represent positive relationship. Well marked clusters of market centres are observed with various levels of transportation on graph. The first group is that of Agra and Jaipur, with high population (6,34,622 and 6,15,258 persons respectively) and very high score of road transport accessibility, and the most important regional centres.

The second cluster of mandi centres consists of relatively medium sized market towns but have equally high score of accessibility. These are Mathura, Bharatpur, Gurgaon and Rewari. First three are district headquarters. Their populations range from 43,885 for Rewari to 1,32,028 for Mathura. After Agra and Jaipur, Mathura is the third largest city of the region. Located along the Yamuna bank, it is an important religious centre also. These market centres, thus, represent various population size groups but all have very high score of accessibility. Hence the two clusters (I & II) come under the category of I order transport nodes. Almost all the I order centres are located along the national highways, are major administrative and/or commercial centres. This proves the hypothesis that the service centres of highest order are associated with higher level of transport network accessibility and vice versa.

The third group of market centres consists of many small clusters with relatively small population size and medium level of accessibility. Alwar is an isolated centre in the scatter diagram, which is relatively medium sized town and has been included in this cluster on the basis of its similar transport score with this group. These are the market centres of II order in the hierarchy of transport accessibility. Palwal is the biggest town among the II order transport nodal points and has maximum accessibility in the group. The other 13

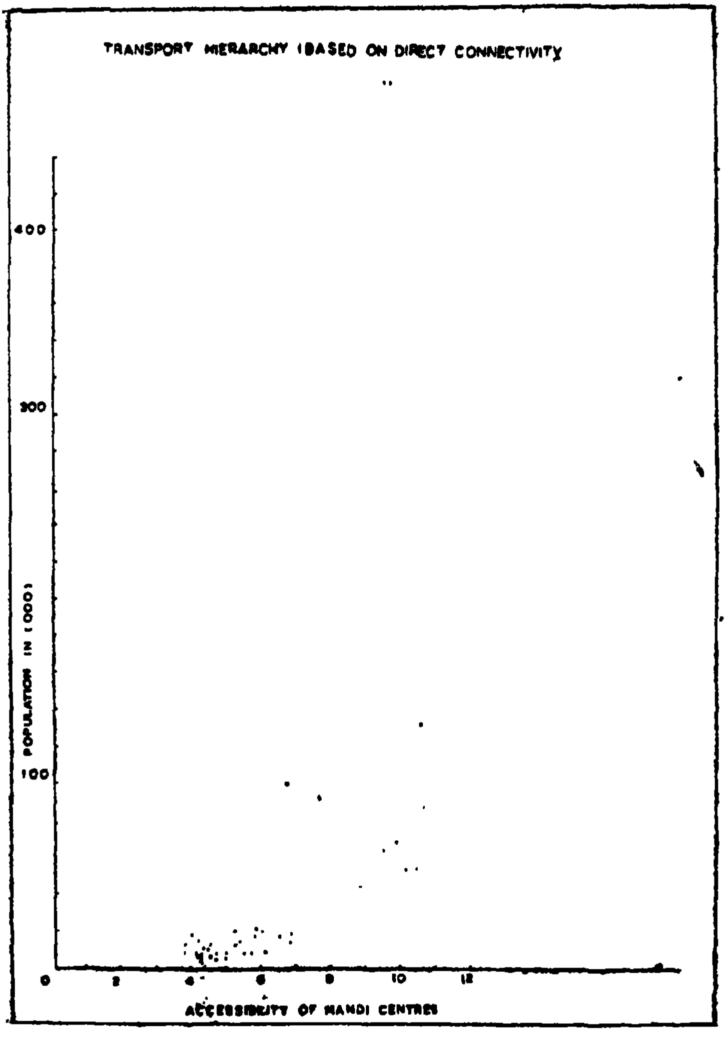

TRANSPORT HIERARCHY (BASED ON DIRECT CONNECTIVITY
400
300
100
POPULATION IN (000)
0
2
4
6
8
10
12
ACCESSIBILITY OF MANDI CENTRES

Fig. : 6.2

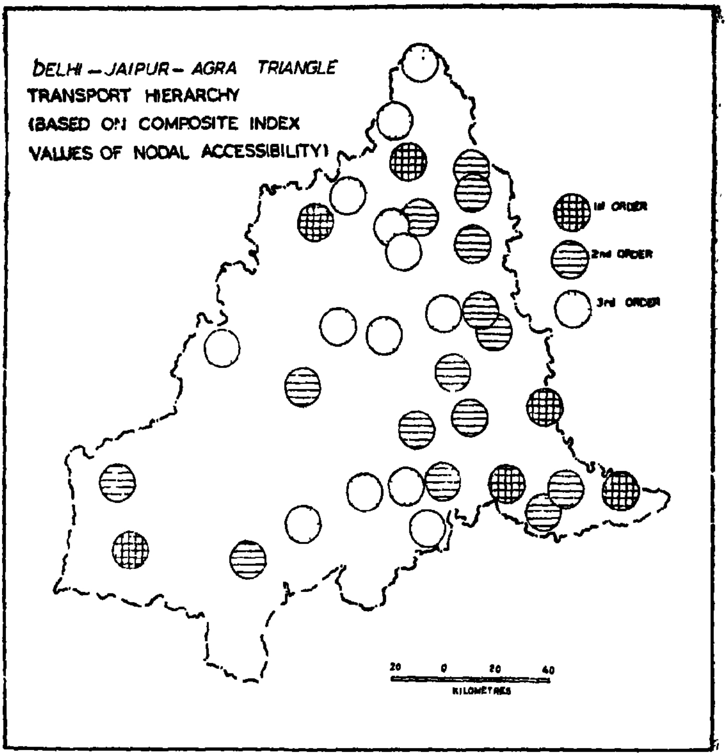

DELHI – JAIPUR – AGRA TRIANGLE
TRANSPORT HIERARCHY
(BASED ON COMPOSITE INDEX
VALUES OF NODAL ACCESSIBILITY)
1st ORDER
2nd ORDER
3rd ORDER
20 0 20 40
KILOMETRES

**Fig. : 6.3**

**Hierarchy of Market Centres**

**(Based on Composite Score of Nodal Accessibility)**

| *I Order* | *Nodal Access-ibility* | *II Order* | *Nodal Acce-ssibility* | *III Order* | *Nodal Access-ibility* |
|---|---|---|---|---|---|
| 1. Mathura | 10.58 | 1. Palwal | 6.98 | 1. Nuh | 5.09 |
| 2. Bharatpur | 9.85 | 2. Kosi Kalan | 6.85 | 2. Mahwa-Mandawar | 5.08 |
| 3. Agra | 9.60 | 3. Hodel | 6.83 | 3. F.P. Jhirka | 4.94 |
| 4. Jaipur | 9.43 | 4. Alwar | 6.68 | 4. Bandikui | 4.71 |
| 5. Rewari | 8.92 | 5. Ballabgarh | 6.45 | 5. Punahana | 4.69 |
| 6. Gurgaon | 7.76 | 6. Nadbai | 6.11 | 6. Tauru | 4.54 |
| | | 7. Fridabad | 6.02 | 7. Kherli | 4.54 |
| | | 8. Deeg | 5.82 | 8. Khairthal | 4.45 |
| | | 9. Nagar | 5.78 | 9. Najafgarh | 4.32 |
| | | 10. Dausa | 5.75 | 10. Pataudi | 4.27 |
| | | 11. Kaman | 5.74 | 11. Narela | 4.04 |
| | | 12. Sohna | 5.55 | 12. Kotputli | 3.82 |
| | | 13. Fatehpur Sikri | 5.37 | 13. Bhusawar | 3.82 |
| | | 14. Achhnera | 5.27 | | |
| | | 15. Chomu | 5.26 | | |

centres of II order have the population range from 22,267 persons (maximum). for Deeg to 8363 persons (maximum) for Nagar. Their nodal accessibility values are 5.82 and 5.78 respectively.

The fourth cluster which represent III order centres, consists of the settlements of smaller size with low transport accessibility. These are Nuh, Mahwa Mandawar, F.P. Jhirka, Bandikui, Punahana, Tauru, Kherli, Khairthal, Najafgarh, Pataudi, Narela, Kotputli and Bhusawar.

The location of all these nodal points on map shows that the I order settlement have marginal location, the II order settlements have middle location and the III order settlements occupy the interior of the region.

## 6.5 Hierarchy based on Local Degree :

The local degree rail and local degree road* have been taken to determine the hierarchy because they are the major contributory variables in the levels of transport network development for individual mandi centres. The two have been composited together after dividing the local degree scores by their respective means. Thus, after making them scale free, the two values (i.e. scale free values for local degree road and local degree for rail) were added for each mandi point. The scale free values have been selected because the local degree rail and total weighed road capacity are not comparable. In figure No. 6.4, Y axis shows population size and composite score of local degree rail and weighed road capacity are represented on X axis. In the scattered diagram, the mandi centres are concentrated in five clusters. Only Palwal and Alwar are isolated centres. On the basis of their accessibility-score both are considered in the III cluster.

Mathura, Agra and Jaipur are the centres of I order (fig. No. 6.5). Their local degree scores are 5.02, 4.95 and 4.89 respectively. Agra and Jaipur are important transport nodal points because they are located at the junctions of many railway lines and many national highways are covering at these points, which give them very high scores. Bharatpur, Rewari and Gurgaon (of medium population size) are second most-important nodal points on the basis of number and importance of rail and road routes crossing or terminating at these places. Chomu, Dausa and Kosi make the third small cluster (their population varies between 18,925 to 20,180 persons separately) and have medium score of local degree rail and total road capacity. Though the population size of Alwar and Palwal is quite large, their transport score is nearer the third group.

* The local degree roads have been taken after weighing with their respective capacities.

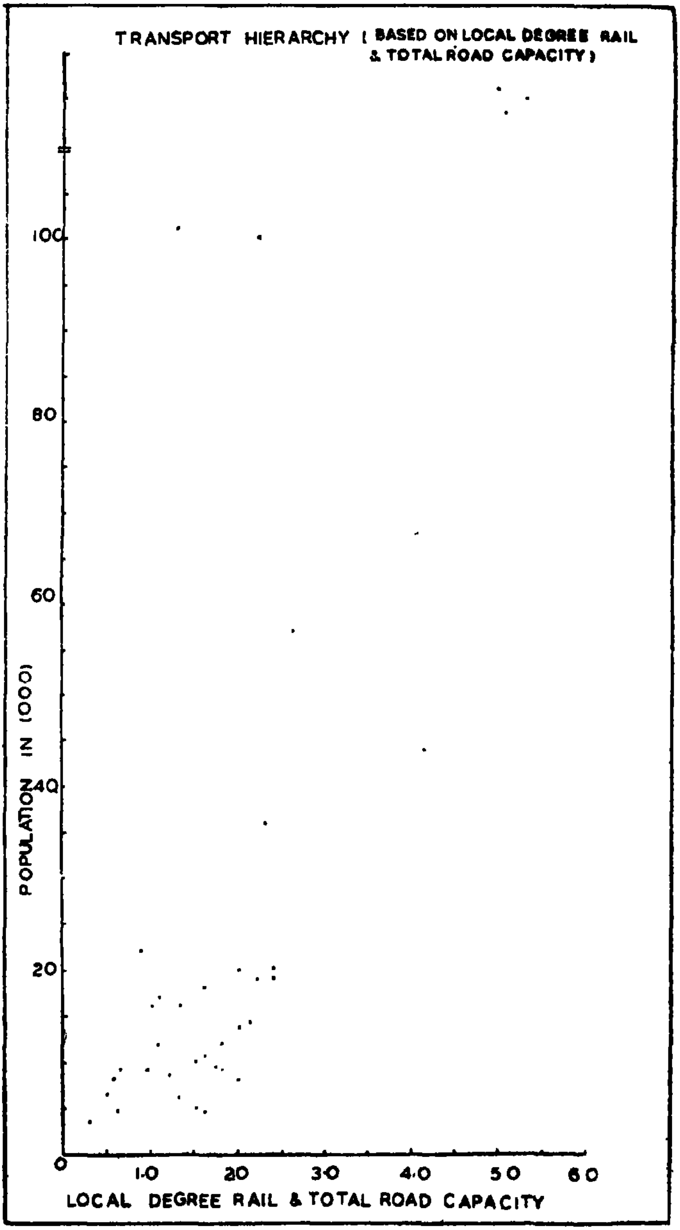

TRANSPORT HIERARCHY ( BASED ON LOCAL DEGREE RAIL & TOTAL ROAD CAPACITY )
POPULATION IN (000)
100
80
60
40
20
0
1·0
2·0
3·0
4·0
5·0
6·0
LOCAL DEGREE RAIL & TOTAL ROAD CAPACITY

Fig. : 6.4

**Hierarchy of Market Centres**

(Based on local degree rail and total road capacity)

| I Order | Composite of L.D. Rail & Total Road Capacity | II Order | Composite of L.D. Rail & Total Road Capacity | III Order | Composite of L.D. Rail & Total Road Capacity | IV Order | Composite of L.D. Rail & Total Road Capacity | V Order | Composite of L.D. Rail & Total Road Capacity |
|---|---|---|---|---|---|---|---|---|---|
| 1. Mathura | 5.02 | 1. Rewari | 4.11 | 1. Chomu | 2.44 | 1. Hadel | 2.12 | 1. Nuh | 0.59 |
| 2. Agra | 4.96 | 2. Bharatpur | 3.99 | 2. Dausa | 2.39 | 2. Bandikui | 2.08 | 2. Bhusawar | 0.55 |
| 3. Jaipur | 9.89 | 3. Gurgaon | 2.65 | 3. Palwal | 2.28 | 3. Fridabad | 2.02 | 3. F.P. Jhirka | 0.54 |
| | | | | 4. Kosi | 2.23 | 4. Fatehpur Sikri | 2.02 | 4 Tauru | 0.48 |
| | | | | 5. Alwar | 2.18 | 5. Achhnera | 1.82 | 5. Punahana | 0.28 |
| | | | | | | 6. Nadbai | 1.81 | | |
| | | | | | | 7. Khairthal | 1.60 | | |
| | | | | | | 8. Narela | 1.60 | | |
| | | | | | | 9. Mahwa | 1.60 | | |
| | | | | | | 10. Kherli | 1.51 | | |

| | | |
|---|---|---|
| 11. | Najafgarh | 1.48 |
| 12. | Pataudi | 1.28 |
| 13. | Nagar | 1.18 |
| 14. | Kotputli | 1.12 |
| 15. | Ballabgarh | 1.12 |
| 16. | Kaman | 0.97 |
| 17. | Sohna | 0.96 |
| 18. | Deeg | 0.90 |

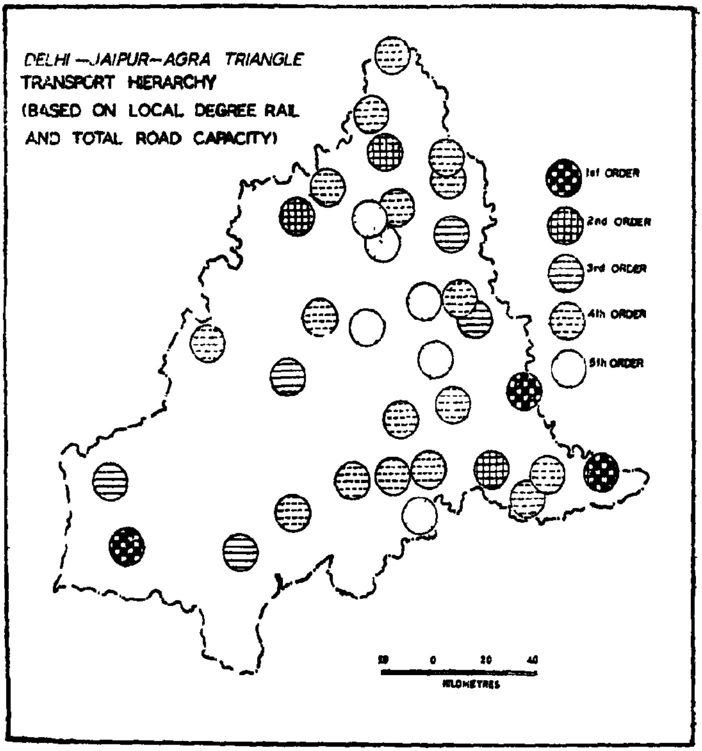

DELHI—JAIPUR—AGRA TRIANGLE
TRANSPORT HIERARCHY
(BASED ON LOCAL DEGREE RAIL
AND TOTAL ROAD CAPACITY)
1st ORDER
2nd ORDER
3rd ORDER
4th ORDER
5th ORDER
0
20
40
KILOMETRES

Fig. : 6.5

There are large number of centres (i.e., Hodel, Bandikui, Faridabad, Fatehpur Sikri, Achhnera, Nadbai, Khairthal, Narela, Mahwa, Kherli, Najafgarh, Pataudi, Nagar, Kotputli, Ballabgarh, Kaman, Sohna and Deeg) which represent 4th category. Nuh, Bhusawar, F.P. Jhirka, Tauru and Punahana are the only centres of 5th group. The centres of V order nodal points are very small in size and have few transport routes touching these centres.

**6.6 Hierarchy of Mandis based on Arrival Size :**

Figure number 6.7 shows that Agra and Jaipur are the I (highest) and II order market centres according to the hierarchical scheme based on arrival size. Their scores are exceptionally high. There is very large gap between II order and III order market centres (Fig. No. 6.6) because of the large variations in their arrival size. There are only four mandis of III order Their scores range from 3.58 for Narela to 4.80 for Rewari. These are Rewari, Alwar, Kherli and Narela. Rest of the mandis are IV order (lowest) collecting centres Except Agra and Kherli all the mandis in between the Aravalli range in the west and Yamuna river in the east are IV order mandis (Fig. No. 6.7). But there is thick net of these mandis which reflects the efficient marketing system, where as in the western part of the region there are few mandis and most of these are located far apart from each other. The farmers of the marginal villages from these mandi-areas have to travel a long distance to sell their produce. This reflects the inefficiency of marketing system. Because of a few markets, the arrival is more in these mandis. Hence these are in II and III order group. Rewari is the only III order mandi in the north. This mandi has relatively large catchment area, hence very high arrivals are recorded.

**6.7 Hierarchy of Mandis based on Arrival Size and Storage Capacity :**

All the mandis of the region may be grouped in four categories. The first group consists of Agra which has very

**Hierarchy of Market Centres**

**(Based on Factor Scores)**

| *I Order* | *Arrival Size* | *II Order* | *Arrival Size* | *III Order* | *Arrival Size* | *IV Order* | *Arrival Size* |
|---|---|---|---|---|---|---|---|
| 1. Agra | 12.42 | 1. Jaipur | 10.82 | 1. Rewari | 4.80 | 1. Najafgarh | 2.90 |
| | | | | 2. Alwar | 4.40 | 2. Mathura | 2.88 |
| | | | | 3. Kherli | 3.91 | 3. Khairthal | 2.55 |
| | | | | 4. Narela | 3.58 | 4. Bharatpur | 2.24 |
| | | | | | | 5. Bandikui | 1.96 |
| | | | | | | 6. Mahwa-Mandawar | 1.72 |
| | | | | | | 7. Kosi-Kalaa | 1.65 |
| | | | | | | 8. Palwal | 1.53 |
| | | | | | | 9. Deeg | 1.49 |
| | | | | | | 10. Dausa | 1.40 |
| | | | | | | 11. Kotputli | 1.39 |
| | | | | | | 12. Nadbai | 1.35 |
| | | | | | | 13. Hodel | 1.33 |
| | | | | | | 14. Kaman | 1.16 |
| | | | | | | 15. Chomu | 1.12 |
| | | | | | | 16. Pataudi | 0.87 |

| | |
|---|---|
| 17. Tauru | 0.67 |
| 18. Nuh | 0.67 |
| 19. Sohna | 0.58 |
| 20. Ballabgarh | 0.54 |
| 21. Faridabad | 0.45 |
| 22. Achhnera | 0.41 |
| 23. Punahana | 0.36 |
| 24. F.P. Sikri | 0.31 |
| 25. Gurgaon | 0.20 |
| 26. Bhusawar | |
| 27. Nagar | |
| 28. F.P. Jhirka | |

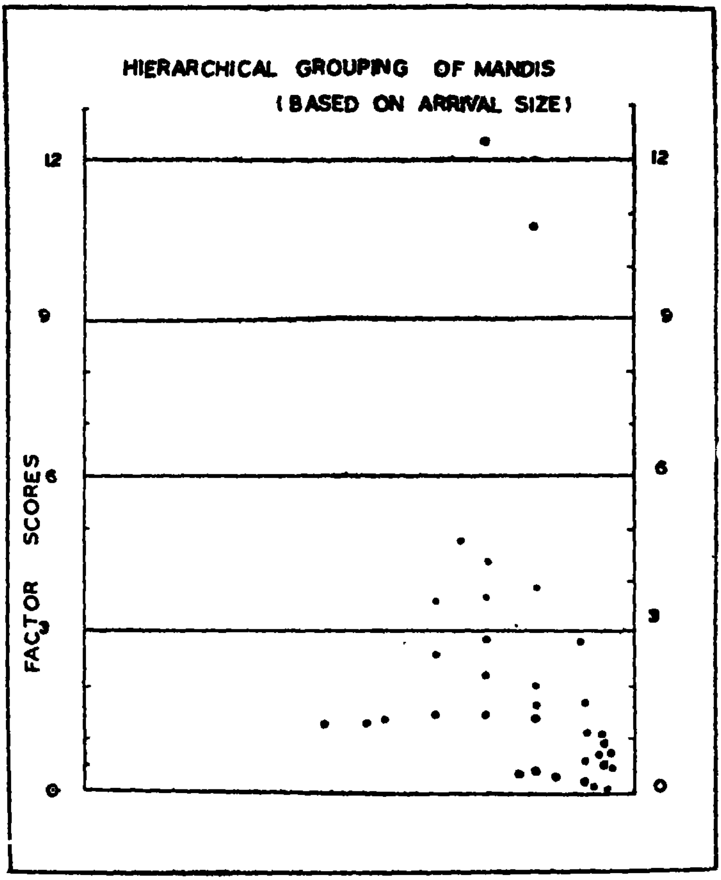

HIERARCHICAL GROUPING OF MANDIS
(BASED ON ARRIVAL SIZE)
FACTOR SCORES
12
9
6
3
0
12
9
6
3
0

Fig. : 6.6

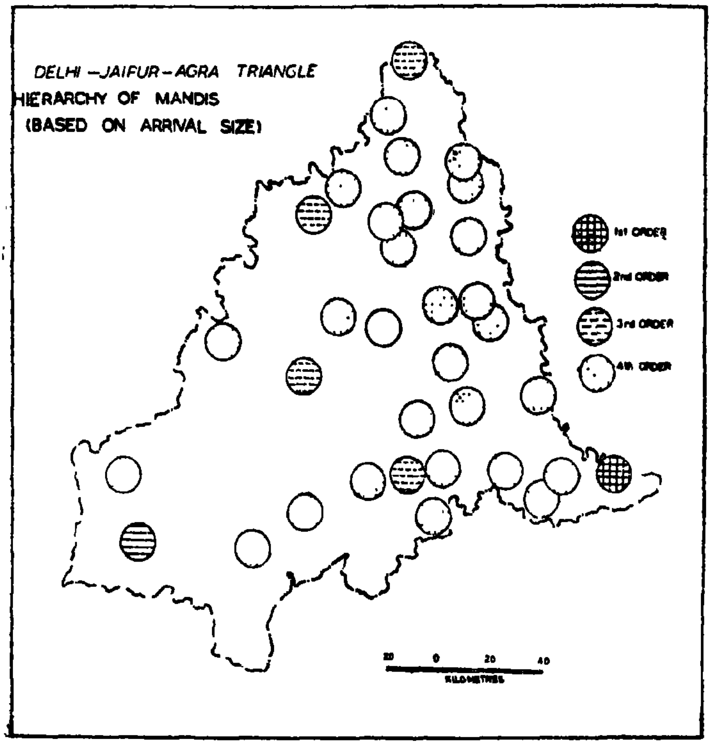

DELHI –JAIPUR – AGRA TRIANGLE
HIERARCHY OF MANDIS
(BASED ON ARRIVAL SIZE)
1st ORDER
2nd ORDER
3rd ORDER
4th ORDER
20 0 20 40
KILOMETRES

Fig. : 6.7

high storage capacity and largest size of arrivals. Faridabad, Mathura and Ballabgarh are the three scattered mandi towns with high storage capacity but low arrivals, The second group of mandis is represented by Jaipur, Alwar, Bharatpur and Kosi market centres. These are characterised with moderate storage capacity and moderate to very high arrival of agricultural produce. The third group of mandi centres is represented by the mandis of small storage capacity but moderate arrivals. (Fig. No. 6.8). Mandis of this group are Khairthal, Rewari and Kherli. The remaining mandis fall in the fourth group having small storage capacity and low arrivals of agricultural produce.

### 6.8 Comparison of Hierarchical Levels based on Transport Network and Mandi Arrivals/Storage Capacity :

There are large regional variations, as discussed earlier, in the physiography and economic health of the region. Physiography influences agricultural productivity (which is one of the basic factors contributing towards marketed surplus) and transport network development in different ways. The western half of the region is characterised by rugged and semi-desert-topography, agricultural backwardness and low population density. Under such conditions, this part could afford very few mandi centres which are located at farther distances as compared to the location of mandis in the eastern part of the region, which has relatively high agricultural productivity. Being sparsely distributed, the mandis in the west have manifold larger area for their hinterlands. In other words, the trade is being shared by the nearby mandis in the eastern region. Because of this fact, the absolute arrival size of agricultural production is much larger in those mandis which have larger catchment areas in general. Due to this complexity of the region, the comparison of the hierarchy of transport nodes with arrival size hierarchy becomes questionable. In all, however, there emerged only three orders of transport hierarchy. Whereas all the mandis are grouped in four orders according to the arrival size scores. In order to make two hierarchies comparable, the I and II order market centres based

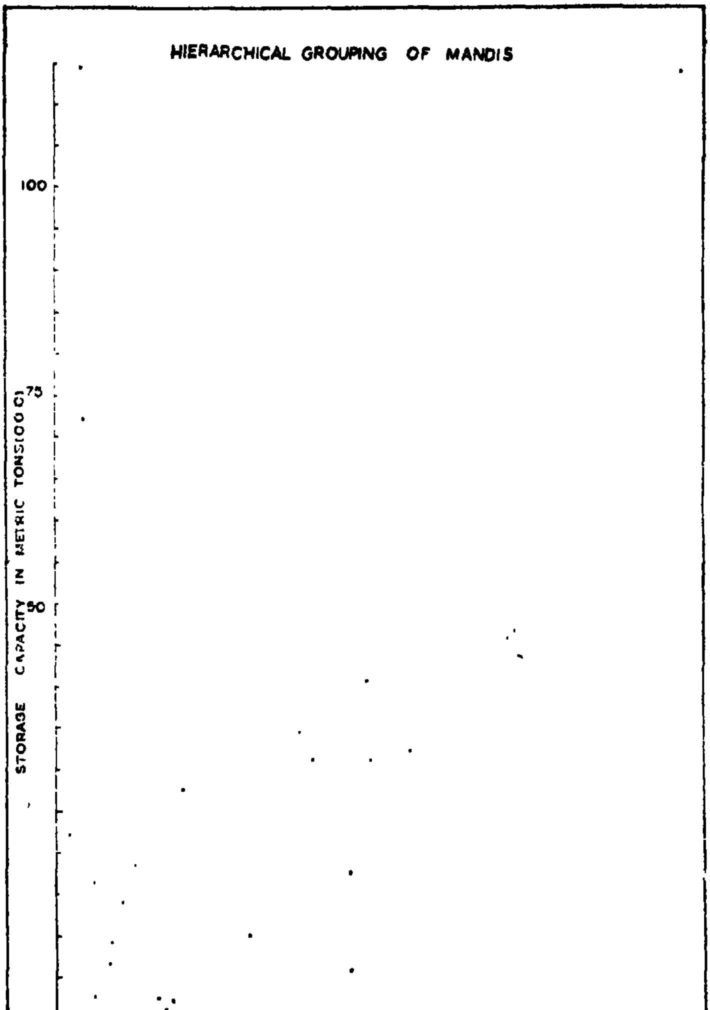

HIERARCHICAL GROUPING OF MANDIS
STORAGE CAPACITY IN METRIC TONS(00 C)
100
75
50
0
20
40
60
80
100
120
140
ARRIVAL OF COMMODITIES IN TERMS OF RS'(000000)

Fig. : 6.8

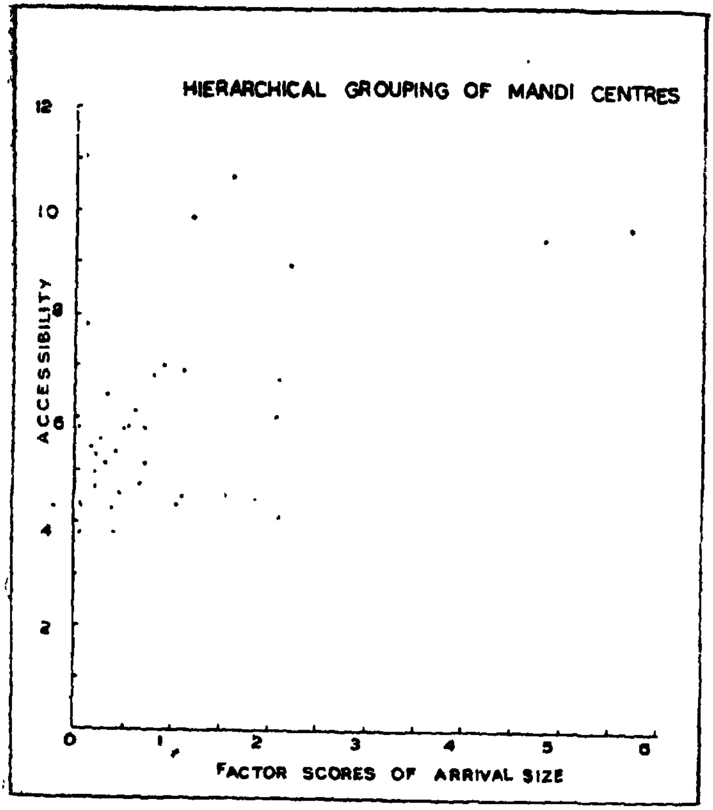

HIERARCHICAL GROUPING OF MANDI CENTRES
ACCESSIBILITY
12
10
8
6
4
2
0
1
2
3
4
5
6
FACTOR SCORES OF ARRIVAL SIZE

Fig. : 6.9

on arrival size have been considered as I order. One of the major contrast in the hierarchical structure based on transport indices and market arrivals is that the latter has large gaps between various orders of market centres. Whereas this type of well marked distinction is not found in the transport hierarchy. But it does not mean that there are no hierarchical break-ups among the transport nodes. Agra and Jaipur which have highest scores for arrivals are I and II order market centres (we shall consider them in I order). They are also the transport nodes of highest order, though their position is third and fourth among the I order transport nodes. Mathura and Bharatpur which have highest scores among the I order transport nodes, fall in the III order of mandi centres (based on arrival size). Gurgaon mandi which has lowest score in the hierarchical group of III order mandis occupies position among the highest order of transport nodal points. Map No. 6.3 shows that all the centres among the eastern border of the region and south-eastern part are of I and II order centres of transport nodes. Whereas, all the mandis in the eastern half of the region (Fig. No. 6.7), except Agra and Narela, emerged the mandis of lowest order (it is again, because their trade is being shared by the neighbouring markets). Most of the mandis in the western half of the region, though there are few, are of higher order. The lowest order of transport nodes occupy longitudinal position in the central part of the region.

**6.9 Hierarchy of Market-Centres (based on Composite Index of Accessibility and arrival size) :**

A simple graphical representation of the composite score of accessibility and arrival size and population provides hierarchical groups of mandi centres. The break points between various orders of market centres are well demonstrated by the gaps which emerged from the graphic array of points plotted in figure No. 6.10. Agra and Jaipur form the highest order of hierarchy because of their largest population size and highest score for arrival size and accessibility (Fig. No. 6.11). Both the market centres are located in extremely south-eastern and south-western corners. These are the market centres of

**Hierarchy of Market Centres**

(Based on Composite Index of Accessibility and Arrival Size

| *I Order* | *Composite of accessibility & Arrival Size* | *II Order* | *Composite of accessibility & Arrival Size* | *III Order* | *Composite of. acccessibility & Arrival Size* | *IV Order* | *Composte of Accessibility and Arrival Size* |
|---|---|---|---|---|---|---|---|
| 1. Agra | 15.31 | 1, Mathura | 12.13 | 1, Alwar | 8.78 | 1. Ballabgarh | 6.74 |
| 2. Jaipur | 14.23 | 2. Rewari | 11.09 | 2. Kosi | 7.96 | 2. Nadbai | 6.73 |
| | | 3. Bharatpur | 11.00 | 3. Palwal | 7.88 | 3. Deeg | 6.50 |
| | | | | 4. Gurgaon | 7.87 | 4. Kherli | 6.32 |
| | | | | 5. Hodel | 7.62 | 5. Dausa | 6.28 |
| | | | | | | 6. Faridabad | 6.27 |
| | | | | | | 7. Kaman | 6 24 |
| | | | | | | 8. Narela | 6.15 |
| | | | | | | 9. Mahwa | 5.84 |
| | | | | | | 10. Nagar | 5.82 |
| | | | | | | 11. Sohna | 5.79 |
| | | | | | | 12. Khairthal | 5.63 |
| | | | | | | 13. Chomu | 5.63 |
| | | | | | | 14. F.P. Sikri | 5.53 |
| | | | | | | 15. Achhnera | 5.47 |

| | |
|---|---|
| 16. Nuh | 5.41 |
| 17. Najafgarh | 5.39 |
| 18. Bandikui | 5.34 |
| 19. F.P. Jhirka | 5.12 |
| 20. Tauru | 5.00 |
| 21. Punahana | 4.87 |
| 22. Pataudi | 4.69 |
| 23. Kotputli | 4.21 |
| 24. Bhusawar | 3.85 |

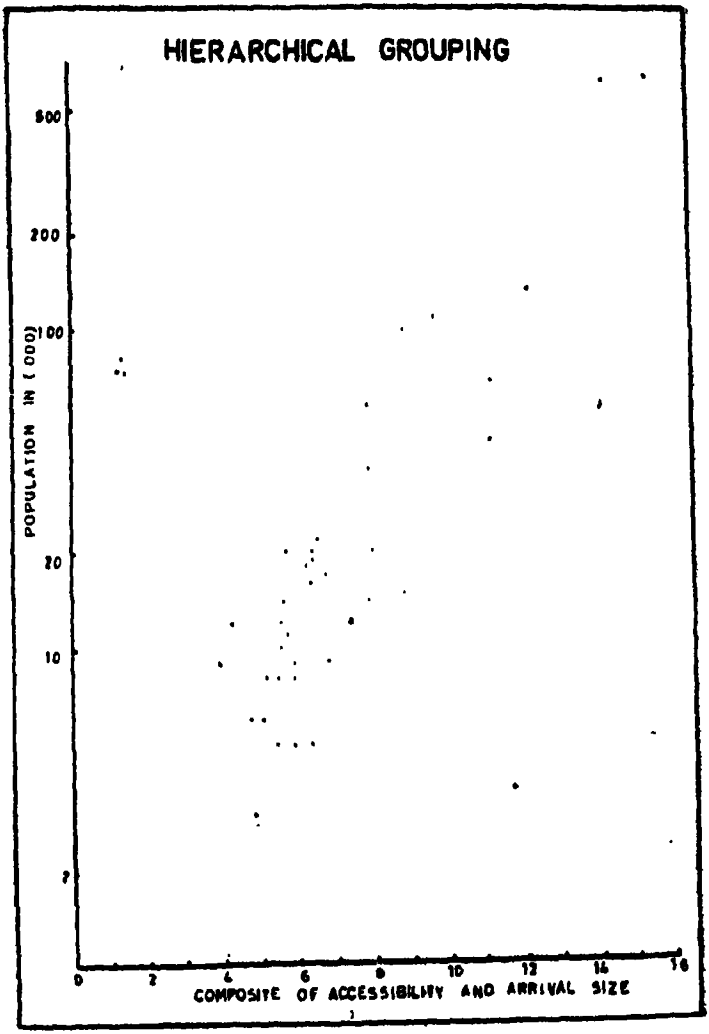

HIERARCHICAL GROUPING
POPULATION IN ( 000)
500
200
100
20
10
2
0
2
4
6
8
10
12
14
16
COMPOSITE OF ACCESSIBILITY AND ARRIVAL SIZE

Fig. : 6.10

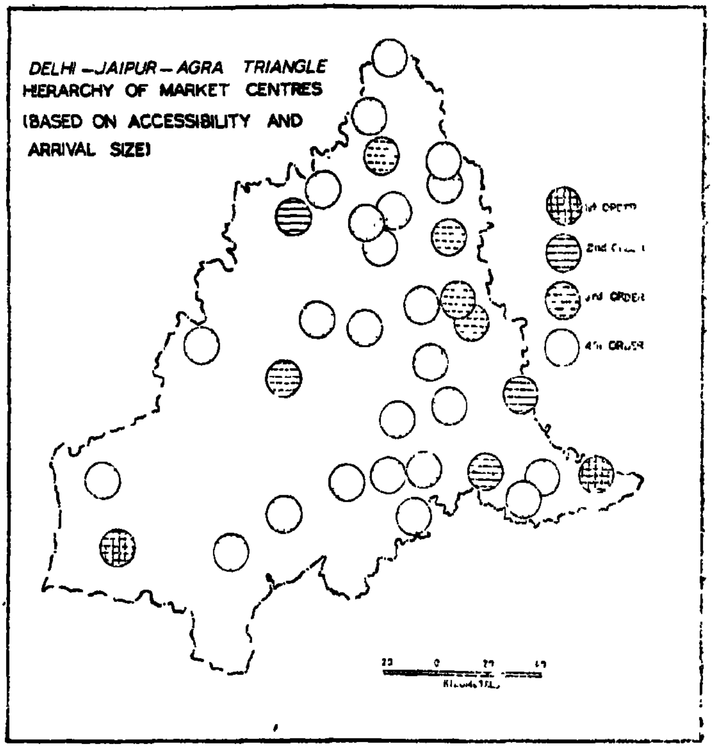

DELHI – JAIPUR – AGRA TRIANGLE
HIERARCHY OF MARKET CENTRES
(BASED ON ACCESSIBILITY AND
ARRIVAL SIZE)

Fig. : 6.11

national importance and are also regional administrative centres. Because of their marginal location and diverse nature of the region it is not possible to test the model of central place theory, as Smith (1972)[7] could arrange three different levels of Market Towns (Central LMT's, Intermediate LMT's, and Peripheral LMT's,) in his study.

The hierarchy based on accessibility scores and mandi arrivals does not coincide with the hierarchy based on the demographic data (percentage of workers engaged in trade and commerce, and percentage of workers engaged in Transport and Communication). Agra and Jaipur which are number one and two in the hierarchy, do not have highest percentages of workers engaged in transport and communication, and trade and commerce. These two centres have medium percentage in these activities. The II order market centres are Mathura, Rewari and Bharatpur. Percentage of workers in transport and communication in these centres is 14, 16 and 10 respectively. The proportion in trade and commerce is 24, 35 and 19 per cent respectively. Rewari is the centre where the precentage of workers in trade and commerce is second to highest. Its position in trade and commerce is also fourth in the region. The III order centres are Alwar, Kosi, Palwal, Gurgaon and Hodel. Among these five centres, highest percentage of workers in transport and communications is for Kosi Kalan (17.83%) it also has highest percentage of workers in trade and commerce 31.53) in the hierarchical group. Four of these centres are located in the north-eastern part of the region. With a few exceptions all I, II and III order market centres are located on the national highways. The remaining 23 market centres are IV order centres. Most of these are located longitudinally from north to south in the central part of the region (Map No. 6.11). Kherli has highest percentage of workers in trade and commerce (45.92%) and Bandikui has highest percentage of workers in transport and communication (52.36%) in the region. Both these market centres are from IV order centres.

7. Carol A. Smith, "Market Articulation and Economic Stratification in Western Guatemala", *FRIS*, Vol. XI, (1972), pp. 203-233.

**6.10 Conclusion :**

Bharatpur, Mathura and Deeg in southeast, Gurgaon in north emerge the transport nodes of highest order based on direct connectivity. Inspite of their largest population size and maximum number of central functions, Agra and Jaipur could not occupy the top most position in the hierarchical levels.

According to the composite index of nodal accessibility, Mathura and Bharatpur are the first and second most important transport nodes among the centres of highest order. Agra and Jaipur, which are the mandi centres of largest population size, however, occupy third and fourth positions in the hierarchical order. All the centres of highest order (Mathura, Bharatpur, Agra, Jaipur, Rewari and Gurgaon) are located along the national highways are important administrative and/or commercial centres, Rewari being an exception. The highest order nodes have peripheral locations, the lowest order transport nodes occupy inner most position. The second order centres are located in between, Mathura, Agra and Jaipur are the centres of highest order according to local degree rail and total road capacity.

Agra and Jaipur are highest order market centres (according to arrival size) but are in two different hierarchical groups. There is very large gap between II and III order market centres because of the large variations in their arrival size. One of the major contrast between transport hierarchy and market centres hierarchy is that the latter has large gaps between various orders of market centres. Whereas this type of well marked distinction is not found in transport hierarchy.

However, we may conclude that there are well marked hierarchical groupings among transport nodes and mandi centres. Generally, the higher order transport nodes are also the higher order market centres.

# 7

# Summary and Findings

7.1 The region of Delhi-Jaipur-Agra National Highway Triangle is characterised by large natural and economic diversities. The western part of the region is hilly and the south-west is semi-deserted. The eastern part is an alluvial plain extending longitudinally along the Yamuna river. Physiographic imprints are well marked over the layout of transport network and distributional pattern of mandis. The drainage system originating from the Aravalli directly influences the transport network, particularly in rainy season.

7.2 The distributional pattern of the mandi centres in the region is more regular than random (Chapter I).

7.3 The region has different types of road networks. The northern part has well developed transport network system which is evident from a thick net of roads. Southwards, there are abrupt changes. Aravalli region has a very poor transport network system. In the south-western part of the region, the settlements are sparsely distributed with poor transport network. Some of the mandi centres which are important focal points (like Agra) have radial type of road network. The mandi hinterlands, where transport network makes maximum number of triangles, quartangles, squares or any other such

type, contribute much to the network structural efficiency. It is because more and more settlements are inter-connected with each other.

7.4 The settlement-accessibility is very high in this region. Nearly 63 per cent of the rural settlements are within a distance of two miles from the roads. In the northern part of the region, 90 per cent of the settlements are within a distance of two miles from the roads. About 70 per cent mandi-hinterlands of the region have more than 50 per cent of the settlements within two miles from the roads. Nearly 32 per cent of the settlements are at a distance of 2 to 4 miles away from the roads. There are only 6 mandi hinterlands where more than 50 per cent villages fall within a distance of 2 to 4 miles from the roads. Hardly 5 per cent of the settlements of the region are located more than 4 miles away from the roads. There is no village in Delhi, Gurgaon, Fridabad and western part of Agra district, which is more than 4 miles away from the road (Chapter II).

7.5 The effectiveness of different transport-network-structural indices varies from mandi hinterland to mandi hinterland. The composite-index of road transport-network represents large regional variation in the levels of transport network development. The notified mandi hinterlands, which have a very high level of development of the road transport network are served by national highways (with few exceptions. Generally those areas where road network is complicated, the level of road transport-network development is also high (as shown by the composite score).

7.6 The level of transport network nodality for different mandi centres also varies from mandi to mandi. Here again all those mandi centres which are lagre transport nodes are located along the transport routes of national importance. They also enjoy better railway connectivity. All the highly accessible mandi centres are located in the periphery of the region. None of the mandis located in the interior of the region has high

accessibility. The sparsely distributed mandis in the vicinity of Aravalli range have generally poor nodal-accessibility score.

7.7 The mandi hinterlands which are located along the national highways have long distance linkages. This can be explained by the fact that national highway tends to link the places of far off distances. The mandi-areas which have interior locations in Delhi-Jaipur-Agra-triangle tend to have restricted distance range. All connections which reflect the high distance-range are gravitated towards Agra, Delhi and Jaipur, indicating their tendency to be closely linked with the national highways and larger urban centres. Generally, the villages of mandi hinterlands of one national highway do not have interactions with the villages located in the mandi hinterlands of the other national highways. The mandi hinterlands which have high connectivity and short distance linkages are a few in number and are located in the central part of the region.

7.8 Generally, the mandis which have large population size and are important administrative centres, record very large marketed surplus.

7.9 Though the northern part of the region has good network of mandi centres, the arrival of different commodities is relatively less in quantity in these mandis because of their small hinterlands as compared to the mandis of the south-west.

7.10 In all the mandis along river Yamuna, wheat is the dominant commodity. One fourth of mandis contribute to three-fourth trade in wheat. There are 13 mandis where wheat is the first major commodity. Barely arrivals dominate only in 6 mandis. Sarson is the first major commodity in 8 mandis located in the central part of the region. These contribute around 56 per cent of the total sarson arrivals in the region.

7.11 Generally the mandis where marketed surplus of wheat has either negative or low growth rate, there barley recorded very high positive annual growth rate and vice versa. Sarson and gram have shown similar growth trends. All the mandis

which have negative growth rate for sarson arrival, also have negative growth for gram, Chomu being an exception. Most of the mandis which have shown negative growth for gram and sarson are located in the fertile and well irrigated belt along the Yamuna river (Chapter III).

7.12 The surplus of agricultural produce is not brought to the mandi in equal proportion all the year round, rather it has seasonal character. 58.47 per cent of the total annual arrival of wheat is recorded during the post harvest period in the months of April, May, June and July. The month of May alone receives 21 per cent of the total wheat. The region receives 14 per cent of barley in the first busiest month (i.e. May only). Half of the total annual arrival of the region's barley comes in the post harvest period. None of the mandis recorded more than 36 per cent of the total barley in any of the busiest months. Nearly half of the total annual arrival of sarson is recorded during the first three most busy months of post harvest period. Its annual arrival ranges from 11 per cent to 38 per cent in the first busiest month. There are certain mandis which receive more than three-fourth of sarson during busiest five months. The seasonal arrival trends of wheat and sarson are comparable. Both have 48 per cent record of arrivals during the three busiest months. 60 per cent of the total annual arrival of gram is received within the four busiest months of post harvest period. There is no mandi in the region which does not receive more than 50 per cent of the total marketed bajra during three busiest months of post harvest period. 57 per cent of the total annual arrival of bajra is received from November to January (post harvest period). Arhar, Gur and Bajra are the commodities for which the total annual arrival is 59 per cent during the three most busy months of post harvest period.

7.13 Sohna, Tauru and Palwal are the only mandis in the region where three commodities out of five record more than 70 per cent arrival during the post harvest season only.

the basis of proportion of commodities marketed in different mandis of the region (Chapter III).

7.15 The indices of transport network structure for mandi hinterlands have poor association with the agricultural marketed surplus. But the indices of transport network nodality have very strong association with the marketed surplus of various commodities. Indices of nodal accessibility explain 46 to 56 per cent variance in marketed surplus of different agricultural products. On the basis of these findings, it may be stated that the study supports the hypothesis that the mandi centres with high nodal accessibility (efficient outlet system) command larger arrivals of the agricultural marketed surplus (Chapter IV).

7.16 There is a close negative association between the number of arrivals of agricultural marketed surplus and distance from the mandi. Away from the collection centres, the frequency of of arrivals declines. But this does not hold true in case of the villages which are highly accessible to the mandis by direct road linkages, particularly in case of Nuh, Hodel and Punahana. This also means that if the villages of mandi hinterland have very high degree of direct road-linkages to the mandi centre, the importance of distance factor declines. This is also true where the mandis are located very close of each other.

7.17 Though the frequeney of arrivals is less from longer distances, the product is brought in comparatively large quantities from far off places. Generally, the villages located along the roads which link them straight to the mandi centres, bring more produce and in larger quantities.

7.18 Nearer the mandi centres, the intensity of marketed surplus increases. The zone of highest intensity of marketed surplus is closest to the mandi centre. But these intensity zones and circular mandi hinterlands are distorted particularly by the Aravalli range. In case of Sohna, for instance, the shape of mandi hinterland is just like 'D'. It is because the farmers can not bring their produce from the western side

where Aravalli works as a physical barrier. There are large variations in the size and direction of the notified mandi hinterlands and the actual mandi hinterlands (Chapter V).

7.19 There is a high positive linear relationship between population size and transport nodality score for different mandis in the region. The large urban centres with numerous central functions have high level of transport network accessibility.

7.20 There are three hierarchical orders of the mandi centres on the basis of their composite score of nodal accessibility. In the first hierarchical order are included 6 transport nodes. These highest order centres are Mathura, Bharatpur, Agra, Jaipur, Rewari and Gurgaon. There are 15 centres of II order. In the third level of hierarchy, there are 13 centres only.

7.21 On the basis of arrival size of marketed surplus, four hierarchical levels emerged. Agra is the highest order grain mandi, Jaipur alone is the next lower order centre. Rewari, Alwar, Kherli and Narela are the III order market centres. The remaining 28 mandis are of the lowest order.

7.22 Based on the composite index of nodal accessibility and arrival size, Agra and Jaipur are the I order centres, Mathura, Rewari and Bharatpur are the II order centres. Third order consists of 5 centres and remaining 24 market centres are of IV order.

7.23 One of the major difference between transport hierarchy and mandi hierarchy is that the latter has large gap between various orders of market centres (mandis). Whereas this type of well marked distinction is not found in the hierarchical orders based on transport network accessibility. There is great is resemblance between both the hierarchies (Chapter VI).

7.24 The typology study of the mandis reveals that the highest order transport nodes or market centres have closest association even with the centres of lowest order, on the basis of Proportion of commodities marketed in different mandis of the region (Chapter III and VI).

## APPENDIX 1—A

**Percentage of Monthly Arrival of Wheat**

| *Mandi* | *Apr.* | *May* | *June* | *July* | *Aug.* | *Sept.* | *Oct.* | *Nov.* | *Dec.* | *Jan.* | *Feb.* | *March* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Khairthal | 14.57 | 36.33 | 22.65 | 11.13 | 2.06 | 4.81 | 2.92 | 2.35 | 1.57 | 0.60 | 0.79 | 0.35 |
| 2. Nuh | 0.00 | 5.01 | 31.50 | 50.65 | 10.30 | 1.73 | 0.09 | 0.14 | 0.13 | 0.07 | 0.25 | 0.09 |
| 3. Gurgaon | 3.85 | 21.23 | 21.88 | 9.33 | 9.05 | 5.05 | 5.13 | 3.35 | 4.45 | 6.92 | 3.40 | 6.32 |
| 4. Jaipur | 10.38 | 14.95 | 11.04 | 9.35 | 6.52 | 7.16 | 8.44 | 6.35 | 9.76 | 7.53 | 4.86 | 3.62 |
| 5. Kosi | 3.48 | 43.83 | 14.72 | 5.68 | 5.13 | 1.70 | 1.85 | 3.84 | 5.81 | 6.08 | 4.09 | 4.28 |
| 6. Agra | 14.73 | 10.43 | 7.[illegible]6 | 5.50 | 5.76 | 5.69 | 7.26 | 9.94 | 7.88 | 9.21 | 8.13 | 7.45 |
| 7. Kaman | 0.00 | 0.00 | 28.95 | 6.43 | 5.08 | 10.51 | 6.72 | 8.01 | 11.08 | 8.29 | 7.58 | 7.43 |
| 8. Fatehpur Sikri | 11.09 | 26.59 | 5.17 | 6.30 | 7.21 | 5.33 | 7.95 | 4.92 | 7.55 | 5.78 | 6.40 | 5.66 |
| 9. Punahana | 0.05 | 5.08 | 17.23 | 17.67 | 34.70 | 9.59 | 9.35 | 4.29 | — | — | — | — |
| 10. F.P. Jhirka | 0.00 | 13.22 | 36.54 | 21.80 | 11.72 | 11.06 | 0.26 | 0.26 | 0.00 | 1.89 | 2.61 | 0.58 |
| 11. Achhnera | 11.85 | 15.02 | 17.75 | 4.46 | 6.22 | 3.67 | 5.54 | 7.31 | 8.72 | 7.20 | 7.43 | 4.89 |
| 12. Alwar | 33.16 | 18.58 | 14.80 | 9.50 | 1.50 | 3.43 | 2.57 | 2.70 | 4.30 | 2.90 | 2.20 | 4.10 |
| 13 Sohna | 5.88 | 18.30 | 34.57 | 19.22 | 11.30 | 5.56 | 1.30 | 0.19 | 0.00 | 1.58 | 0.35 | 1.69 |
| 14. Bandikui | 16.50 | 20.33 | 10.00 | 7.30 | 4.60 | 6.96 | 5.51 | 5.80 | 8.80 | 4.10 | 5.20 | 4.70 |
| 15. Kherli | 19.23 | 29.35 | 16.42 | 7.23 | 4.02 | 4.02 | 4.40 | 2.55 | 5.11 | 2.55 | 3:23 | 2.48 |
| 16. Mathura | 15.20 | 36.94 | 13.62 | 1.32 | 2.09 | 1.62 | 2.39 | 1.00 | 3.84 | 16.02 | 4.35 | 1.84 |
| 17. Narela | 22.54 | 26.76 | 1.00 | 6.48 | 4.86 | 4.72 | 4.46 | 4.55 | 4.14 | 3.24 | 3.44 | 2.92 |
| 18. Najafgarh | 12.84 | 25.20 | 12.96 | 9.05 | 7.05 | 4.47 | 3.84 | 7.45 | 6.52 | 4.13 | 3.83 | 2.85 |

## APPENDIX 1—B

### Percentage of Monthly Arrival of Barley

| Mandi | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | March |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Khairthal | 15.80 | 25.90 | 11.24 | 13.90 | 3.90 | 5.10 | 5.20 | 12.00 | 4.30 | 1.20 | 0.60 | 0.60 |
| 2. Nuh | 16.16 | 21.19 | 11.29 | 14.77 | 15.88 | 2.49 | 1.80 | 3.38 | 3.47 | 6.25 | 2.53 | 1.76 |
| 3. Gurgaon | 6.40 | 21.88 | 11.68 | 6.78 | 7.61 | 5.55 | 5.90 | 11.68 | 3 80 | 7.40 | 9.20 | 1.87 |
| 4. Jaipur | 8.12 | 7.70 | 8.71 | 11,00 | 5.60 | 6.90 | 9.10 | 12.24 | 9.80 | 5.90 | 8.30 | 6.60 |
| 5. Kosi | 18.89 | 21.61 | 21.56 | 6.87 | 8.40 | 1.41 | 2.56 | 3.85 | 0.34 | 0.16 | 10.13 | 4.20 |
| 6. Agra | 7.02 | 6.40 | 6.71 | 3.93 | 7.48 | 6.76 | 16.27 | 8.31 | 8.53 | 11.50 | 9.83 | 7.22 |
| 7. Kaman | 11.56 | 21.16 | 17.29 | 9.89 | 13.14 | 2.09 | 2.11 | 6.41 | 2.50 | 4.85 | 6.32 | 2.65 |
| 8. Fatehpur Sikri | 15.94 | 23.96 | 9.84 | 9.60 | 1.98 | 5.44 | 11.63 | 1.78 | 6.93 | 5.39 | 3.86 | 3.61 |
| 9. Punahana | 15.16 | 17.75 | 12.98 | 17.46 | 20.93 | 4.41 | 1.48 | 1.27 | 2.57 | 3.52 | 0.19 | 2.23 |
| 10. F.P. Jhirka | 6.39 | 14.49 | 6.42 | 23.37 | 10.19 | 3.72 | 2.37 | 2.75 | 2.20 | 16.98 | 3.24 | 7.82 |
| 11. Achhnera | 12.18 | 1.59 | 9.04 | 9.18 | 11.39 | 11.82 | 11.66 | 10.84 | 6.83 | 6.67 | 4.65 | 4.10 |
| 12. Alwar | 9.00 | 22.18 | 9.76 | 13.00 | 6.30 | 6.68 | 8.30 | 10.87 | 5.88 | 3.00 | 2.30 | 2.50 |
| 13. Sohna | 12.36 | 35.56 | 16.70 | 10.19 | 7.10 | 2.80 | 3.70 | 2.50 | 2.70 | 4.56 | 0.77 | 0.87 |
| 14. Bandikui | 8.00 | 12.90 | 4.98 | 7.20 | 4.50 | 8.90 | 10.30 | 11.40 | 11.80 | 6.00 | 7.70 | 6.12 |
| 15. Kherli | 14.01 | 29.50 | 10.79 | 6.60 | 5.80 | 6.78 | 5.90 | 5.60 | 8.90 | 2.00 | 2.00 | 1.80 |
| 16. Mathura | 11.55 | 11.06 | 9.77 | 9.79 | 13.04 | 5.23 | 4.09 | 4.35 | 6.50 | 13.28 | 8.73 | 2.57 |
| 17. Narela | 17.48 | 12.44 | 7.19 | 6.62 | 3.68 | 1.92 | 1.76 | 7.77 | 13.82 | 2.87 | 8.15 | 16.31 |
| 18. Najafgarh | 23.25 | 9.92 | 4.34 | 2.84 | 1.20 | 1.69 | 5.55 | 16.40 | 5.78 | 15.67 | 8.22 | 5.14 |

## APPENDIX 1—C

**Percentage of Monthly Arrival of Sarson**

| Mandi | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | March |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Khairthal | 42.30 | 8.10 | 2.20 | 5.00 | 2.40 | 7.00 | 4.60 | 4.10 | 3.60 | 2.30 | 1.40 | 16.80 |
| 2. Nuh | 33.08 | 6.25 | 5.60 | 5.10 | 9.27 | 3 04 | 1 73 | 2.84 | 2.17 | 3.52 | 3.47 | 19.87 |
| 3. Gurgaon | 10.98 | 15.69 | 7.50 | 23.23 | 13.63 | 1.27 | 2.93 | 4.50 | 5.90 | 6.50 | 0.46 | 7.18 |
| 4. Kosi | 25.33 | 17.78 | 11.96 | 5.10 | 3.70 | 1 60 | 4.20 | 4.80 | 5.40 | 7.90 | 2.20 | 8.98 |
| 5. Agra | 3.41 | 9.33 | 8.23 | 6.81 | 9.14 | 6.98 | 8.41 | 8.27 | 8.63 | 11.20 | 11.14 | 8.40 |
| 6. Kaman | 31.81 | 13.73 | 7.86 | 6 20 | 7.21 | 3.21 | 3.13 | 3.77 | 3.42 | 3.30 | 3.46 | 12.89 |
| 7. Fatehpuri Sikri | 20.50 | 29.07 | 4.63 | 2.91 | 15 96 | 6.19 | 9 57 | 1.85 | 0.75 | 1.91 | 5.53 | 1.07 |
| 8. Punahana | 26.24 | 9.99 | 8.54 | 7.50 | 11.23 | 6.51 | 0.00 | 3.80 | 3.81 | 3.09 | 0.76 | 8.78 |
| 9. F.P. Jhirka | 15.80 | 10.45 | 0.17 | 10.17 | 15.39 | 9.89 | 1.11 | 8.34 | 5.48 | 9.90 | 2.24 | 11.03 |
| 10. Achhnera | 15.94 | 35.16 | 7.64 | 6.71 | 6 46 | 3.88 | 5.27 | 7.51 | 3.16 | 3.19 | 2.60 | 2.36 |
| 11. Alwar | 17.17 | 10.00 | 2.48 | 8.54 | 5.50 | 6.00 | 7.10 | 5.10 | 5.30 | 2.10 | 5.20 | 25.17 |
| 12. Sohna | 51.18 | 7.50 | 6.40 | 4.67 | 5.19 | 0.58 | 8.83 | 1.66 | 0.39 | 4.24 | 0.68 | 8.60 |
| 13. Kherli | 30.56 | 10.56 | 3.37 | 5.08 | 4.78 | 6.80 | 4.39 | 2.99 | 4.76 | 2.40 | 2.75 | 21.45 |
| 14. Mathura | 21.10 | 11.40 | 8.10 | 6.60 | 7.00 | 5.90 | 5.90 | 7.56 | 14.55 | 7.90 | 1.70 | 2.17 |
| 15. Narela | 16.01 | 14.47 | 8.51 | 6.71 | 8.98 | 12.44 | 8.29 | 6.51 | 6.47 | 6.19 | 1.82 | 3.60 |
| 16. Najafgarh | 26.60 | 14.61 | 9.34 | 3.19 | 5.08 | 3.47 | 7.61 | 14.19 | 7.16 | 5.94 | 1.88 | 0.94 |

## APPENDIX 1—D

### Percentage of Monthly Arrival of Bajra

| Mandi | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | March |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Khairthal | 0.04 | 0.09 | 0.15 | 3.55 | 0.47 | 0.27 | 37.61 | 37.72 | 13.81 | 4.49 | 1.18 | 0.61 |
| 2. Nuh | — | — | — | — | — | — | 1.47 | 17.80 | 41.59 | 23.61 | 6.39 | 4.13 |
| 3. Gurgaon | — | — | 1.57 | 0.86 | — | — | 4.14 | 18.71 | 30.57 | 28.00 | 13.29 | 2.86 |
| 4. Jaipur | 4.93 | 2.05 | 3.57 | 5.31 | 2.50 | 2.65 | 12.16 | 16.89 | 19.57 | 13.58 | 11.26 | 5.54 |
| 5. Kosi | 1.68 | 0.20 | 0.46 | — | — | — | 1.27 | 20.97 | 37.47 | 16.73 | 12.68 | 8.54 |
| 6. Agra | 2.02 | 1.89 | 1.20 | 0.71 | 0.30 | 0.12 | 0.61 | 6.10 | 19.65 | 32.84 | 20.84 | 13.71 |
| 7. Kaman | 0.20 | 0.03 | 0.42 | 0.40 | 0.00 | 0.04 | 1.82 | 14.04 | 34.60 | 20.71 | 20.90 | 6.84 |
| 8. Fatehpur Sikri | — | — | — | — | — | — | — | 28.12 | 30.93 | 20.74 | 12.64 | 7.56 |
| 9. Punahana | — | — | — | — | — | — | — | 36.52 | 3.85 | 34.62 | — | 25.00 |
| 10. F.P. Jhirka | — | — | 0.75 | — | — | — | 4.39 | 20.55 | 27.32 | 28.88 | 14.16 | 3.95 |
| 11. Achhnera | — | — | — | — | — | — | 9.87 | 31.49 | 24.92 | 16.85 | 10.85 | 6.30 |
| 12. Alwar | 0.42 | 0.84 | 0.59 | 1.51 | 0.30 | 0.44 | 16.39 | 37.06 | 28.46 | 9.79 | 3.50 | 0.68 |
| 13. Sohna | 0.03 | 0.03 | 1.59 | 0.03 | 0.03 | 4.45 | 31.18 | 24.07 | 0.03 | 32.37 | 2.23 | 3.96 |
| 14. Bandikui | 2.86 | 1.73 | 1.83 | 1.38 | 1.44 | 2.85 | 27.77 | 20.40 | 21.64 | 8.99 | 5.73 | 3.38 |
| 15. Mathura | 12.90 | 1.37 | 0.96 | 1.53 | 0 | 1.12 | 6.64 | 4.09 | 34.05 | 21.64 | 10.16 | 5.54 |
| 16. Narela | 1.82 | 1.69 | 0.85 | 0.79 | 0.10 | 0.45 | 26.25 | 27.51 | 9.98 | 15.88 | 9.78 | 5.25 |
| 17. Najafgarh | 4.14 | 0.92 | 1.70 | 2.33 | 0.50 | 0.52 | 4.80 | 25.38 | 21.30 | 29.40 | 4.22 | 4.78 |

## APPENDIX 1—E

**Percentage of Monthly Arrival of Gram**

| Mandi | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | March |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Khairthal | 27.32 | 21.91 | 10.74 | 7.24 | 2.93 | 3.13 | 5.15 | 8.14 | 3.22 | 2.03 | 4.95 | 4.07 |
| 2. Nuh | 19.12 | 23.24 | 9.38 | 7.99 | 9.47 | 6.89 | 5.05 | 6.39 | 4.19 | 1.81 | 1.98 | 4.43 |
| 3. Gurgaon | 6.98 | 12.35 | 11.01 | 16.05 | 21.45 | 3.52 | 10.58 | 3.02 | 0.64 | 2.70 | 1.30 | 9.90 |
| 4. Jaipur | 17.23 | 22.91 | 9.30 | 11.00 | 3.80 | 3.90 | 7.40 | 8.10 | 6.00 | 4.04 | 4.30 | 1.90 |
| 5. Kosi | 48.08 | 29.21 | 10.34 | 2.37 | 1.11 | 0.14 | 0.84 | 3.45 | 0.48 | 0.17 | 0.25 | 3.52 |
| 6. Agra | 3.92 | 5.34 | 6.22 | 5.14 | 5.96 | 5.42 | 16.68 | 10.05 | 10.40 | 10.09 | 10.18 | 10.54 |
| 7. Kaman | 10.80 | 22.01 | 14.21 | 6.35 | 9.73 | 3.62 | 4.68 | 16.16 | 3.31 | 2.39 | 2.51 | 4.22 |
| 8. Fatehpur Sikri | 8.43 | 17.97 | 19.69 | 19.63 | 5.32 | 3.43 | 6.81 | 1.99 | 4.21 | 3.66 | 4.26 | 4.65 |
| 9. Punahana | 12.73 | 14.22 | 12.96 | 10.07 | 19.13 | 16.86 | 3.43 | 4.61 | 1.51 | 2.85 | 1.31 | 0.26 |
| 10. F.P. Jhirka | 5.54 | 24.26 | 10.85 | 13.62 | 9.25 | 15.28 | 4.21 | 8.86 | 1.95 | 4.46 | 0.79 | 0.88 |
| 11. Achhnera | 9.93 | 17.65 | 17.83 | 9.52 | 6.05 | 4.50 | 8.57 | 11.07 | 9.72 | 1.24 | 1.86 | 2.11 |
| 12. Alwar | 15.10 | 23.60 | 8.20 | 12.30 | 3.70 | 4.10 | 6.70 | 10.00 | 4.90 | 4.20 | 3.88 | 3.08 |
| 13. Sohna | 4.59 | 21.90 | 32.00 | 2.40 | 18.00 | 1.76 | 0.70 | 7.77 | 0.35 | 7.40 | 0.00 | 2.47 |
| 14. Bandikui | 21.99 | 10.40 | 5.40 | 6.90 | 3.30 | 7.30 | 11.90 | 8.00 | 6.90 | 5.20 | 6.00 | 6.50 |
| 15. Kherli | 28.00 | 20.40 | 10.97 | 4.98 | 2.86 | 4.60 | 8.20 | 5.50 | 0.00 | 3.88 | 5.27 | 5.10 |
| 16. Mathura | 11.50 | 24.82 | 18.21 | 10.05 | 7.93 | 4.17 | 8.04 | 2.25 | 2.72 | 1.92 | 3.70 | 4.70 |
| 17. Narela | 13.04 | 39.01 | 17.20 | 8.40 | 4.23 | 7.61 | 2.99 | 2.16 | 1.54 | 1.17 | 1.07 | 1.58 |
| 18. Najafgarh | 16.00 | 39.94 | 13.12 | 10.34 | 2.59 | 6.83 | 6.73 | 0.76 | 1.01 | 0.76 | 1.30 | 0.62 |

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